SHARP

POCKET COMPUTER

ELSI MATE

PC-1201

APPLICATIONS MANUAL

INTRODUCTION

SHARP POCKET COMPUTER PC – 1201

APPLICATIONS MANUAL

Thank you for your purchase of the SHARP pocket computer Model "PC-1201". This booklet contains various programs for the Sharp Pocket Computer PC-1201. Careful reading of this manual will enable you to use your new SHARP to its full capability.

The contents of the manual are as follows:

1. TITLE
   Each program is given a brief TITLE summarizing the contents of the program.

2. PROGRAM NO.
   P2 shows this machine, next A – X shows the classification and the next No. explains the series of the No. in the classified field.

3. ANGLE DESIGNATION
   In performing the program, the angle to be set is shown in the angle selector switch giving the Mark□. It is needless to operate the selector switch, in case the designation is not made with the mark□.

4. FORMULA
   This column shows the contents of the program, formula, etc.

5. EXAMPLE
   In this column, the calculation example is given.

6. OPERATION

In this column, the method of operation for the calculation example is given.

Note: In making the program, please operate the machine, confirming that the number displayed is exactly the same number as indicated in the calculation example.

7. STEP

This shows the STEP NO. of the program made in the PRO mode.

8. KEY

This shows the key operation of the program as above. If 2 or 3 keys are mentioned in the same line, please operate the key from left to right.

9. KEY CODE

This shows the code of the display appeared in the display register, after the key operation of one line.

10. MEMORY

This is the column showing the contents of the memory used in the program. It will be described as needed.

11. LABEL

This is the column of JUMP and SUB ROUTINE used in the program.

12. NOTE

This is the column for remarks.

APPLICATIONS MANUAL FOR PC 1201

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SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE HYPERBOLIC & INVERSE HYPERBOLIC FUNTIONS

PROGRAM NO. P2－A－1

[Formula]

code number

$$\sinh x = \frac{e^x - e^{-x}}{2} \quad \cdots\cdots 1$$

$$\cosh x = \frac{e^x + e^{-x}}{2} \quad \cdots\cdots 2$$

$$\tanh x = \frac{e^x - e^{-x}}{e^x + e^{-x}} \quad \cdots\cdots 3$$

$$\sinh^{-1} x = \ln\left(x + \sqrt{x^2 + 1}\right) \quad \cdots\cdots -1$$

$$(-\infty < x < \infty)$$

$$\cosh^{-1} x = \ln\left(x + \sqrt{x^2 - 1}\right) \quad \cdots\cdots -2$$

$$(1 \leqq x < \infty)$$

$$\tanh^{-1} x = \ln\sqrt{\frac{1+x}{1-x}} \quad \cdots\cdots -3$$

$$(-1 < x < 1)$$

[Example]

$\sinh 1.2 = 1.509\cdots\cdots$ $\quad \sinh^{-1} 0.5 = 0.481\cdots\cdots$

$\cosh 1.2 = 1.810\cdots\cdots$ $\quad \cosh^{-1} 5 = 2.2924\cdots\cdots$

$\tanh 1.2 = 0.833\cdots\cdots$ $\quad \tanh^{-1} 0.5 = 0.549\cdots\cdots$

[Operation] CA

i) (code number) 1 S/E

(x) 1.2 S/E 1.509461355

ii) (code number) 2 +/− S/E

(x) 5 S/E 2.29243167

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
0		x→M	t	55	83	32		M+	0	75	00
1			C·CE		35	33		RM	0	65	00
2		F	HLT	F	12	34			÷		44
3		x→M	s	55	82	35			2		02
4		RM	t	65	83	36			=		84
5	F	$x<0$	1	F 65	01	37			S/E		85
6			−		64	38	F	LBL	2	F 13	02
7			2		02	39		RM	s	65	82
8			=		84	40			e^x		32
9	F	$x<0$	2	F 65	02	41		x→M	0	55	00
10			−		64	42		F	1/x	F	43
11			1		01	43			+/−		82
12			=		84	44		M+	0	75	00
13	F	$x<0$	3	F 65	03	45		RM	0	65	00
14		RM	s	65	82	46			÷		44
15			e^x		32	47			2		02
16		F	x^2	F	44	48			=		84
17			+		74	49			S/E		85
18			1		01	50	F	LBL	1	F 13	01
19			=		84	51			+		74
20		x→M	0	55	00	52			3		03
21			−		64	53			=		84
22			2		02	54	F	$x\neq0$	4	F 55	04
23			÷		44	55		RM	s	65	82
24		RM	0	65	00	56		x→M	0	55	00
25			=		84	57			1		01
26			S/E		85	58		M+	s	75	82
27	F	LBL	3	F 13	03	59			−		64
28		RM	s	65	82	60		RM	0	65	00
29			e^x		32	61			÷		44
30		x→M	0	55	00	62		RM	s	65	82
31		F	1/x	F	43	63			↕		45

MEMORY

s	x	4	
t	code	5	
0	√	6	
1		7	
2		8	
3		9	

LABEL

s		4	√
t		5	√
0		6	
1	√	7	
2	√	8	
3	√	9	

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
64			=		84	96					
65		F	√	F	42	97					
66			ln		33	98					
67			S/E		85	99					
68	F	LBL	4	F 13	04	100					
69			−		64	101					
70			1		01	102					
71			=		84	103					
72	F	$x\neq0$	5	F 55	05	104					
73		RM	s	65	82	105					
74		F	x^2	F	44	106					
75			−		64	107					
76			1		01	108					
77			=		84	109					
78		F	√	F	42	110					
79			+		74	111					
80		RM	s	65	82	112					
81			=		84	113					
82			ln		33	114					
83			S/E		85	115					
84	F	LBL	5	F 13	05	116					
85		RM	s	65	82	117					
86		F	x^2	F	44	118					
87			+		74	119					
88			1		01	120					
89			=		84	121					
90		F	√	F	42	122					
91			+		74	123					
92		RM	s	65	82	124					
93			=		84	125					
94			ln		33	126					
95			S/E		85	127					

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2-A-2

TITLE **POLYNOMIAL EVALUATION**

[Formula]

Polynomial evaluation can be made according to the following formula.

$$f(x)=a_n x^n+a_{n-1}x^{n-1}+\cdots\cdots\cdots+a_1 x+a_0$$

[Example]

$f(x)=5x^3+4x^2+3x+2$

$f(4)=398$

$f(-1)=-2$

[Operation]

CA

x S/E

a_n S/E

a_{n-1} S/E

a_{n-2} S/E

⋮

a_2 S/E

a_1 S/E

a_0 S/E display $f(x)$

(operation of example)

CA

(x) 4 S/E

(a_3) 5 S/E

(a_2) 4 S/E

(a_1) 3 S/E

(a_0) 2 S/E $f(4)=398$

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	t	55	83	32				
1	F	HLT	F	12	33				
2	x→M	s	55	82	34				
3	F LBL	t	F 13	83	35				
4	F	HLT	F	12	36				
5	x→M	0	55	00	37				
6	RM	t	65	83	38				
7		x		54	39				
8	RM	s	65	82	40				
9		+		74	41				
10	RM	0	65	00	42				
11		=		84	43				
12	x→M	s	55	82	44				
13	GTO	t	14	83	45				
14					46				
15					47				
16					48				
17					49				
18					50				
19					51				
20					52				
21					53				
22					54				
23					55				
24					56				
25					57				
26					58				
27					59				
28					60				
29					61				
30					62				
31					63				

MEMORY			
s	a_n	4	
t	x	5	
0	a_{n-1}	6	
1		7	
2		8	
3		9	

LABEL			
s		4	
t	√	5	
0		6	
1		7	
2		8	
3		9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2–A–3

TITLE SIMULTANEOUS EQUATIONS OF TWO UNKNOWNS

[Formula]

This program solves for x and y for two independent equations given as follows:

$$\begin{cases} a_{11}x + a_{12}y = d_1 & \text{①} \\ a_{21}x + a_{22}y = d_2 & \text{②} \end{cases}$$

$$x = \frac{d_1a_{22} - d_2a_{12}}{a_{11}a_{22} - a_{21}a_{12}} \qquad y = \frac{d_2a_{11} - d_1a_{21}}{a_{11}a_{22} - a_{21}a_{12}}$$

[Example]

$$\begin{cases} 2x + 3y = 8 \\ x + y = 3 \end{cases} \qquad x = 1 \qquad y = 2$$

[Operation]

CA

(a_{11}) 2 S/E

(a_{12}) 3 S/E

(d_1) 8 S/E

(a_{21}) 1 S/E

(a_{22}) 1 S/E

(d_2) 3 S/E (x) 1

S/E (y) 2

Notes: If the calculator displays Error, no solution or no unique solution exists.

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	t	55	83	32	RM	4	65	04
1	F	HLT	F	12	33		=		84
2	x→M	s	55	82	34	F	HLT	F	12
3	F	HLT	F	12	35	RM	3	65	03
4	x→M	0	55	00	36		×		54
5	F	HLT	F	12	37	RM	t	65	83
6	x→M	1	55	01	38		−		64
7	F	HLT	F	12	39		(		42
8	x→M	2	55	02	40	RM	0	65	00
9	F	HLT	F	12	41		×		54
10	x→M	3	55	03	42	RM	1	65	01
11	RM	t	65	83	43		)		43
12		×		54	44		÷		44
13	RM	2	65	02	45	RM	4	65	04
14		−		64	46		=		84
15		(		42	47		S/E		85
16	RM	s	65	82	48				
17		×		54	49				
18	RM	1	65	01	50				
19		)		43	51				
20		=		84	52				
21	x→M	4	55	04	53				
22	RM	0	65	00	54				
23		×		54	55				
24	RM	2	65	02	56				
25		−		64	57				
26		(		42	58				
27	RM	3	65	03	59				
28		×		54	60				
29	RM	s	65	82	61				
30		)		43	62				
31		÷		44	63				

MEMORY

s	a_{12}	4	$a_{11}a_{22} - a_{12}a_{21}$
t	a_{11}	5	
0	d_1	6	
1	a_{21}	7	
2	a_{22}	8	
3	d_2	9	

LABEL

s	4
t	5
0	6
1	7
2	8
3	9

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2-A-4

TITLE **QUADRATIC EQUATION**

[Formula]

The roots x of $ax^2+bx+c=0$ $(a \neq 0)$ are given by

$$x=\frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

1) If $b^2-4ac>0$

$$x=\frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

2) If $b^2-4ac=0$

$$x=-\frac{b}{2a}$$

3) If $b^2-4ac<0$

Real part: $\dfrac{-b}{2a}$

Imaginary part: $\dfrac{\sqrt{4ac-b^2}}{2a}$

[Example]

(1) $4x^2-x-1=0$ $\quad x=1,\ -0.5$

(2) $5x^2+4x+1=0$

Real part -0.4, Imaginary part 0.2

[Operation]

If $b^2-4ac \geqq 0$,

CA

(a) 4 S/E

(b) 1 +/− S/E

(c) 1 +/− S/E 6.403882033×10⁻¹

↓ −3.903882033×10⁻¹

If $b^2-4ac<0$

CA

(a) 5 S/E

(b) 4 S/E

(c) 1 S/E −0.4 (real part)

↓ 0.2 (imaginary part)

Note: In case of $b^2-4ac<0$, the calculator displays real part with the peep at HLT condition.
In case of $b^2-4ac \geqq 0$, the calculator displays a solution without the peep at END condition.

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
0		x→M	t	55	83	32			÷		44
1		F	HLT	F	12	33			2		02
2		x→M	s	55	82	34			÷		44
3		F	HLT	F	12	35		RM	t	65	83
4		x→M	0	55	00	36			=		84
5		RM	s	65	82	37			+/−		82
6			x		54	38			‡		45
7		RM	s	65	82	39		RM	3	65	03
8			−		64	40			S/E		85
9			(		42	41	F	LBL	t	F 13	83
10			4		04	42			+/−		82
11			x		54	43		F	√	F	42
12		RM	t	65	83	44		x→M	2	55	02
13			x		54	45			2		02
14		RM	0	65	00	46			x		54
15			)		43	47		RM	t	65	83
16			=		84	48			=		84
17		x→M	1	55	01	49		x→M	3	55	03
18	F	x<0	t	F 65	83	50		RM	s	65	82
19		F	√	F	42	51			÷		44
20		x→M	2	55	02	52		RM	3	65	03
21			−		64	53			=		84
22		RM	s	65	82	54			+/−		82
23			÷		44	55		x→M	4	55	04
24			2		02	56		RM	2	65	02
25			÷		44	57			÷		44
26		RM	t	65	83	58		RM	3	65	03
27			=		84	59			=		84
28		x→M	3	55	03	60			‡		45
29		RM	s	65	82	61		RM	4	65	04
30			+		74	62		F	HLT	F	12
31		RM	2	65	02	63			S/E		85

MEMORY				LABEL			
s	b	4		s		4	
t	a	5		t		5	
0	c	6		0		6	
1	$D=b^2-4ac$	7		1		7	
2	$\sqrt{D}$	8		2		8	
3		9		3		9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO
P2–A–5

TITLE COMPLEX ARITHMETIC (+, −, x, ÷, ENTRY)

[Formula]

The arithmetic operations (+, −, x, ÷, ENTRY) are defined as follows:

[+] ..... [GTO] [1] [S/E]　　[−] ..... [GTO] [2] [S/E]

[X] ..... [GTO] [3] [S/E]　　[÷] ..... [GTO] [4] [S/E]

[ENTRY] ..... [GTO] [5] [S/E]

Note: Since this operation is also defined as "Reverse Polish Notation", [ENTRY] should be operated at first.

(Input) (Output)

Y: Real part | ⇨ X, M3: Real part

X: Imaginary part | Y, M4: Imaginary part

[Example]

(Example 1)

$(5+3\,i)+(2+7\,i)-(3-3\,i)=4+13\,i$

(Example 2)

$(5+3\,i)\times(2+7\,i)\div(3-3\,i)=-8.66\cdots61+5.000\cdots4\,i$

[Operation]

Find solutions of example 2;

(a) 5 [↕]

(b) 3 [GTO] [5] [S/E] (ENTRY)

(a) 2 [↕]

(b) 7 [GTO] [3] [S/E] (×)

(a) 3 [↕]

(b) 3 [+/−] [GTO] [4] [S/E] (÷)

(Real part) −8.666666661

[↕] (Imaginary part) 5.000000004

Note: This example is shown in DEG mode.

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0	F	LBL	1	F	13	01	32		x→M	2		55	02
1		M+	4		75	04	33		RM	5		65	05
2			↕			45	34			×			54
3		M+	3		75	03	35		RM	1		65	01
4		RM	4		65	04	36			=			84
5			↕			45	37		x→M	1		55	01
6		RM	3		65	03	38			↕			45
7			S/E			85	39		RM	2		65	02
8	F	LBL	2	F	13	02	40		F	$\rightarrow xy$		F	74
9			+/−			82	41		x→M	3		55	03
10		M+	4		75	04	42			↕			45
11			↕			45	43		x→M	4		55	04
12			+/−			82	44			↕			45
13		M+	3		75	03	45			S/E			85
14		RM	4		65	04	46	F	LBL	4	F	13	04
15			↕			45	47		F	$\rightarrow r\theta$		F	64
16		RM	3		65	03	48		x→M	1		55	01
17			S/E			85	49			↕			45
18	F	LBL	3	F	13	03	50		x→M	2		55	02
19		F	$\rightarrow r\theta$		F	64	51		RM	3		65	03
20		x→M	1		55	01	52			↕			45
21			↕			45	53		RM	4		65	04
22		x→M	2		55	02	54		F	$\rightarrow r\theta$		F	64
23		RM	3		65	03	55		x→M	5		55	05
24			↕			45	56			↕			45
25		RM	4		65	04	57			−			64
26		F	$\rightarrow r\theta$		F	64	58		RM	2		65	02
27		x→M	5		55	05	59			=			84
28			↕			45	60		x→M	2		55	02
29			+			74	61		RM	5		65	05
30		RM	2		65	02	62			÷			44
31			=			84	63		RM	1		65	01

MEMORY				LABEL			
s		4	Imaginary	s		4	√
t		5	r	t		5	√
0		6	θ	0		6	
1	r	7		1	√	7	
2	θ	8		2	√	8	
3	Real	9		3	√	9	

STEP	KEY		KEY CODE	STEP	KEY		KEY CODE
64		=	84	96			
65	x→M	1	55 01	97			
66		↕	45	98			
67	RM	2	65 02	99			
68	F	→xy	F 74	100			
69	x→M	3	55 03	101			
70		↕	45	102			
71	x→M	4	55 04	103			
72		↕	45	104			
73		S/E	85	105			
74	F LBL	5	F 13 05	106			
75	x→M	4	55 04	107			
76		↕	45	108			
77	x→M	3	55 03	109			
78		C·CE	35	110			
79		S/E	85	111			
80				112			
81				113			
82				114			
83				115			
84				116			
85				117			
86				118			
87				119			
88				120			
89				121			
90				122			
91				123			
92				124			
93				125			
94				126			
95				127			

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE RECTANGULAR TO SPHERICAL COORDINATE CONVERSION

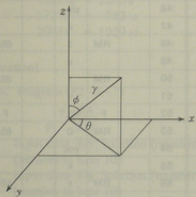
PROGRAM NO. P2–A–6

[Formula]

$$\begin{cases} x = \gamma \sin\phi \cos\theta \\ y = \gamma \sin\phi \sin\theta \\ z = \gamma \cos\phi \end{cases} \rightleftarrows \begin{cases} \gamma = \sqrt{x^2+y^2+z^2} \\ \theta = \tan^{-1}\dfrac{y}{x} \\ \phi = \cos^{-1}\left(z/\sqrt{x^2+y^2+z^2}\right) \end{cases}$$

Note: θ : The angle to x axis in xy plane
ϕ : The angle to z axis
x, y, z: Positive number

[Example]



[Operation]

$(x, y, z) \rightarrow (\gamma, \theta, \phi)$

CA

(x) 3 S/E

(y) 4 S/E

(z) 5 S/E (γ) 7.071067812 (φ) 45

S/E (θ) 53.13010235

S/E (φ) 45

$(\gamma, \theta, \phi) \rightarrow (x, y, z)$

(γ) 7 GTO 2 S/E

(θ) 53 S/E

S/E (x) 2.978832387

S/E (y) 3.953044094

S/E (z) 4.949747468

Note: This example is shown in DEG mode.

STEP	KEY		KEY CODE	
0	x→M	t	55	83
1	F	HLT	F	12
2	x→M	s	55	82
3	F	HLT	F	12
4	x→M	0	55	00
5	F	x^2	F	44
6	x→M	1	55	01
7	RM	t	65	83
8	F	x^2	F	44
9	M+	1	75	01
10	RM	s	65	82
11	F	x^2	F	44
12	M+	1	75	01
13	RM	1	65	01
14	F	$\sqrt{}$	F	42
15	x→M	1	55	01
16	F	HLT	F	12
17	RM	s	65	82
18		÷		44
19	RM	t	65	83
20		=		84
21	F	$\tan^{-1}$	F	24
22	F	HLT	F	12
23	RM	0	65	00
24		÷		44
25	RM	1	65	01
26		=		84
27	F	$\cos^{-1}$	F	23
28		S/E		85
29	F LBL	2	F 13	02
30	x→M	t	55	83
31	F	HLT	F	12

STEP	KEY		KEY CODE	
32	x→M	s	55	82
33	F	HLT	F	12
34	x→M	0	55	00
35		sin		22
36	x→M	1	55	01
37	RM	s	65	82
38		cos		23
39		x		54
40	RM	1	65	01
41		x		54
42	RM	t	65	83
43		=		84
44	F	HLT	F	12
45	RM	s	65	82
46		sin		22
47		x		54
48	RM	1	65	01
49		x		54
50	RM	t	65	83
51		=		84
52	F	HLT	F	12
53	RM	0	65	00
54		cos		23
55		x		54
56	RM	t	65	83
57		=		84
58	F	HLT	F	12
59	GTO	2	14	02
60				
61				
62				
63				

MEMORY

s	y, ϕ	4
t	x, r	5
0	z, θ	6
1	$\sqrt{x^2+y^2+z^2}$, $\sin\theta$	7
2		8
3		9

LABEL

s		4
t		5
0		6
1		7
2	$\sqrt{}$	8
3		9

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **BASE CONVERSION I, II (10 ⇄ P)**

PROGRAM NO.
P2–A–7 A–8

[Formula]

This program (P2–A–7) changes a number in base 10 to a number in base P. And another program (P2–A–8) does vice versa.

Note: P: Positive integer number, $2 \leq P \leq 9$
Any number (both in base 10 and base P) is integer and Max. 9 digits.

[Example]

$983_{10} = 1727_8$
$1029_{10} = 2005_8$
$1727_8 = 983_{10}$
$2005_8 = 1029_{10}$

[Operation]

☆ Program (P2–A–7)

CA
P S/E CA
Input data S/E Solution (number in base P) 8 S/E
(number in base 10)
Input data S/E Solution (number in base P) 983_{10} S/E 1727_8
(number in base 10) 1029_{10} S/E 2005_8

☆ Program (P2–A–8)

CA
P S/E CA
Input data S/E Solution (number in base 10) 8 S/E
(number in base P)
Input data S/E Solution (number in base 10) 1727_8 S/E 983_{10}
(number in base P) 2005_8 S/E 1029_{10}

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0		x→M	t		55	83	32			–			64	64			(			42
1	F	LBL	0	F	13	00	33			7			07	65			(			42
2			↕			45	34			=			84	66			(			42
3			0			00	35	F	x≠0	3	F	55	03	67		RM	0		65	00
4		x→M	0		55	00	36			1			01	68			x			54
5		x→M	1		55	01	37			0			00	69		RM	s		65	82
6		x→M	2		55	02	38		x→M	s		55	82	70			+			74
7		x→M	3		55	03	39			(			42	71		RM	4		65	04
8		x→M	4		55	04	40			(			42	72			)			43
9		x→M	5		55	05	41			(			42	73			x			54
10		x→M	6		55	06	42		RM	9		65	09	74		RM	s		65	82
11		x→M	7		55	07	43			x			54	75			+			74
12			↕			45	44		RM	s		65	82	76		RM	3		65	03
13		F	HLT		F	12	45			+			74	77			)			43
14	F	LBL	2	F	13	02	46		RM	8		65	08	78			x			54
15		x→M	8		55	08	47			)			43	79		RM	s		65	82
16			÷			44	48			x			54	80			+			74
17		RM	t		65	83	49		RM	s		65	82	81		RM	2		65	02
18			=			84	50			+			74	82			)			43
19		F	int		F	84	51		RM	7		65	07	83			x			54
20		x→M	9		55	09	52			)			43	84		RM	s		65	82
21			x			54	53			x			54	85			+			74
22		RM	t		65	83	54		RM	s		65	82	86		RM	1		65	01
23			=			84	55			+			74	87			=			84
24			+/-			82	56		RM	6		65	06	88		GTO	0		14	00
25		M+	8		75	08	57			)			43	89	F	LBL	3	F	13	03
26		RM	9		65	09	58			x			54	90	F	GTS	4	F	14	04
27	F	x<t	1	F	85	01	59		RM	s		65	82	91		GTO	1		14	01
28	F	GTS	4	F	14	04	60			+			74	92			S/E			85
29		GTO	2		14	02	61		RM	5		65	05	93	F	LBL	4	F	13	04
30	F	LBL	1	F	13	01	62			=			84	94			1			01
31		RM	0		65	00	63		x→M	0		55	00	95		M+	0		75	00

MEMORY

s	10	4	√
t	P	5	√
0	count	6	√
1	√	7	√
2	√	8	√
3	√	9	√

LABEL

s	4	√
t	5	
0	√	6
1	√	7
2	√	8
3	√	9

NOTE

Program No.

P2–A–7.

STEP	KEY			KEY CODE		
0		x→M	t		55	83
1	F	LBL	0	F	13	00
2			↕			45
3			0			00
4		x→M	0		55	00
5		x→M	1		55	01
6		x→M	2		55	02
7		x→M	3		55	03
8		x→M	4		55	04
9		x→M	5		55	05
10		x→M	6		55	06
11		x→M	7		55	07
12			↕			45
13		F	HLT		F	12
14	F	LBL	2	F	13	02
15		x→M	8		55	08
16			÷			44
17			1			01
18			0			00
19			=			84
20		F	int		F	84
21		x→M	9		55	09
22			x			54
23			1			01
24			0			00
25			=			84
26			+/−			82
27		M+	8		75	08
28		RM	9		65	09
29	F	x<t	1	F	85	01
30	F	GTS	4	F	14	04
31		GTO	2		14	02

STEP	KEY			KEY CODE		
32	F	LBL	1	F	13	01
33		RM	0		65	00
34			−			64
35			7			07
36			=			84
37	F	x≠0	3	F	55	03
38			(			42
39			(			42
40			(			42
41		RM	9		65	09
42			x			54
43		RM	t		65	83
44			+			74
45		RM	8		65	08
46			)			43
47			x			54
48		RM	t		65	83
49			+			74
50		RM	7		65	07
51			)			43
52			x			54
53		RM	t		65	83
54			+			74
55		RM	6		65	06
56			)			43
57			x			54
58		RM	t		65	83
59			+			74
60		RM	5		65	05
61			=			84
62		x→M	0		55	00
63			(			42

MEMORY

s		4	√
t	P	5	√
0	count	6	√
1	√	7	√
2	√	8	√
3	√	9	√

LABEL

s		4	√
t		5	
0	√	6	
1	√	7	
2	√	8	
3	√	9	

STEP	KEY			KEY CODE		
64			(			42
65			(			42
66		RM	0		65	00
67			x			54
68		RM	t		65	83
69			+			74
70		RM	4		65	04
71			)			43
72			x			54
73		RM	t		65	83
74			+			74
75		RM	3		65	03
76			)			43
77			x			54
78		RM	t		65	83
79			+			74
80		RM	2		65	02
81			)			43
82			x			54
83		RM	t		65	83
84			÷			74
85		RM	1		65	01
86			=			84
87		GTO	0		14	00
88	F	LBL	3	F	13	03
89	F	GTS	4	F	14	04
90		GTO	1		14	01
91			S/E			85
92	F	LBL	4	F	13	04
93			1			01
94		M+	0		75	00
95		RM	2		65	02

STEP	KEY			KEY CODE		
96		x→M	1		55	01
97		RM	3		65	03
98		x→M	2		55	02
99		RM	4		65	04
100		x→M	3		55	03
101		RM	5		65	05
102		x→M	4		55	04
103		RM	6		65	06
104		x→M	5		55	05
105		RM	7		65	07
106		x→M	6		55	06
107		RM	8		65	08
108		x→M	7		55	07
109		RM	9		65	09
110		x→M	8		55	08
111			0			00
112		x→M	9		55	09
113		RM	8		65	08
114			S/E			85
115						
116						
117						
118						
119						
120						
121						
122						
123						
124						
125						
126						
127						

NOTE

Program No.
P2–A–8

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2-A-9

TITLE **BASE CONVERSION III (10 ⇄ 16)**

[Formula]

This program changes a number in base 10 to a number in base 16 and vice versa.

A digit in hexdecimal number is shown in two digits of the calculator.

[Example]

$$983_{10} = \underset{3\ D\ 7}{3\ 13\ 07_{16}}$$

$$\underset{3\ D\ 7}{3\ 13\ 07_{16}} = 983_{10}$$

[Operation]

☆ Change decimal number to hexdecimal number:

CA

983 S/E 31307 (3 D 7)

1029 S/E 40005 (4 0 5)

☆ Change hexdecimal number to decimal number:

31307 GTO 2 S/E 983

40005 S/E 1029

STEP	KEY		KEY CODE	STEP	KEY		KEY CODE
0	F	CAM	F 45	32	x→M	9	55 09
1	x→M	t	55 83	33		x	54
2		1	01	34	RM	3	65 03
3		6	06	35		=	84
4	x→M	3	55 03	36		+/–	82
5		1	01	37	M+	8	75 08
6		0	00	38	RM	9	65 09
7		0	00	39		–	64
8	x→M	4	55 04	40	RM	3	65 03
9	RM	t	65 83	41		=	84
10	F GTS	3	F 14 03	42	F x<0	4	F 65 04
11		S/E	85	43		1	01
12	F LBL	2	F 13 02	44	M+	0	75 00
13	F	CAM	F 45	45	RM	6	65 06
14	x→M	t	55 83	46	x→M	5	55 05
15		1	01	47	RM	7	65 07
16		6	06	48	x→M	6	55 06
17	x→M	4	55 04	49	RM	8	65 08
18		1	01	50	x→M	7	55 07
19		0	00	51	RM	9	65 09
20		0	00	52	GTO	3	14 03
21	x→M	3	55 03	53	F LBL	4	F 13 04
22	RM	t	65 83	54	RM	0	65 00
23	F GTS	3	F 14 03	55		–	64
24	F	HLT	F 12	56		3	03
25	GTO	2	14 02	57		=	84
26	F LBL	3	F 13 03	58	F x≠0	5	F 55 05
27	x→M	8	55 08	59		(	42
28		÷	44	60		(	42
29	RM	3	65 03	61		(	42
30		=	84	62	RM	9	65 09
31	F	int	F 84	63		x	54

MEMORY			
s		4	100, 16
t	data	5	√
0	count	6	√
1		7	√
2		8	√
3	16, 100	9	√

LABEL			
s		4	√
t		5	√
0		6	
1		7	
2	√	8	
3	√	9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64		RM	4	65	04	96	x→M	9	55	09				
65		+			74	97	GTO	4	14	04				
66		RM	8	65	08	98		S/E		85				
67		)			43	99								
68		x			54	100								
69		RM	4	65	04	101								
70		+			74	102								
71		RM	7	65	07	103								
72		)			43	104								
73		x			54	105								
74		RM	4	65	04	106								
75		+			74	107								
76		RM	6	65	06	108								
77		)			43	109								
78		x			54	110								
79		RM	4	65	04	111								
80		+			74	112								
81		RM	5	65	05	113								
82		=			84	114								
83		S/E			85	115								
84	F	LBL	5	F	13	05	116							
85			1			01	117							
86		M+	0		75	00	118							
87		RM	6		65	06	119							
88		x→M	5		55	05	120							
89		RM	7		65	07	121							
90		x→M	6		55	06	122							
91		RM	8		65	08	123							
92		x→M	7		55	07	124							
93		RM	9		65	09	125							
94		x→M	8		55	08	126							
95			0			00	127							

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **DETERMINANT OF A 3x3 MATRIX**

PROGRAM NO. P2–A–10

[Formula]

This program computes the determinant of a 3 x 3 matrix.

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix} = a_{11}a_{22}a_{33}+a_{21}a_{32}a_{13}+a_{31}a_{12}a_{23} - (a_{11}a_{32}a_{23}+a_{12}a_{21}a_{33}+a_{31}a_{22}a_{13})$$

[Example]

$$\begin{vmatrix} 1 & 1 & 1 \\ 2 & -1 & 1 \\ 3 & 2 & -1 \end{vmatrix} = 11$$

[Operation]

CA

(a_{11}) 1 S/E

(a_{21}) 2 S/E

(a_{31}) 3 S/E

(a_{12}) 1 S/E

(a_{22}) 1 +/− S/E

(a_{32}) 2 S/E

(a_{13}) 1 S/E

(a_{23}) 1 S/E

(a_{33}) 1 +/− S/E 11

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	t	55	83	32	RM	4	65	04
1	F	HLT	F	12	33		×		54
2	x→M	s	55	82	34	RM	3	65	03
3	F	HLT	F	12	35		)		43
4	x→M	0	55	00	36		=		84
5	F	HLT	F	12	37	x→M	8	55	08
6	x→M	1	55	01	38	RM	1	65	01
7	F	HLT	F	12	39		×		54
8	x→M	2	55	02	40	RM	5	65	05
9	F	HLT	F	12	41		−		64
10	x→M	3	55	03	42		(		42
11	F	HLT	F	12	43	RM	4	65	04
12	x→M	4	55	04	44		×		54
13	F	HLT	F	12	45	RM	2	65	02
14	x→M	5	55	05	46		)		43
15	F	HLT	F	12	47		=		84
16	x→M	6	55	06	48		×		54
17		x		54	49	RM	0	65	00
18	RM	2	65	02	50		+		74
19		−		64	51		(		42
20		(		42	52	RM	t	65	83
21	RM	3	65	03	53		×		54
22		x		54	54	RM	7	65	07
23	RM	5	65	05	55		)		43
24		)		43	56		−		64
25		=		84	57		(		42
26	x→M	7	55	07	58	RM	s	65	82
27	RM	1	65	01	59		×		54
28		x		54	60	RM	8	65	08
29	RM	6	65	06	61		)		43
30		−		64	62		=		84
31		(		42	63		S/E		85

MEMORY

s	a_{21}	4	a_{13}
t	a_{11}	5	a_{23}
0	a_{31}	6	a_{33}
1	a_{13}	7	√
2	a_{23}	8	√
3	a_{33}	9	

LABEL

s		4	
t		5	
0		6	
1		7	
2		8	
3		9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **INVERSE OF A 3×3 MATRIX**

PROGRAM NO. P2–A–11

[Formula]

This program inverts a 3 x 3 matrix.

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}^{-1} = \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{pmatrix}$$

[Example]

$$\begin{pmatrix} 1 & -1 & 2 \\ 2 & -1 & 7 \\ 1 & -1 & 3 \end{pmatrix}^{-1} = \begin{pmatrix} 4 & 1 & -5 \\ 1 & 1 & -3 \\ -1 & 0 & 1 \end{pmatrix}$$

[Operation]

		CA
(a_{11})	1	S/E
(a_{21})	2	S/E
(a_{31})	1	S/E
(a_{12})	1	+/− S/E
(a_{22})	1	+/− S/E
(a_{32})	1	+/− S/E
(a_{13})	2	S/E
(a_{23})	7	S/E
(a_{33})	3	S/E (b_{11}) 4
		S/E (b_{21}) 1
		S/E (b_{31}) − 1
		S/E (b_{12}) 1
		S/E (b_{22}) 1
		S/E (b_{32}) 0
		S/E (b_{13}) − 5
		S/E (b_{23}) − 3
		S/E (b_{33}) 1

STEP	KEY		KEY CODE	
0	x→M	t	55	83
1	F	HLT	F	12
2	x→M	s	55	82
3	F	HLT	F	12
4	x→M	0	55	00
5	F	HLT	F	12
6	x→M	1	55	01
7	F	HLT	F	12
8	x→M	2	55	02
9	F	HLT	F	12
10	x→M	3	55	03
11	F	HLT	F	12
12	x→M	4	55	04
13	F	HLT	F	12
14	x→M	5	55	05
15	F	HLT	F	12
16	x→M	6	55	06
17	F	GTS	1	F	14	01
18	F	GTS	1	F	14	01
19	F	GTS	1	F	14	01
20	RM	t	65	83
21	F	HLT	F	12
22	RM	s	65	82
23	F	HLT	F	12
24	RM	0	65	00
25	F	HLT	F	12
26	RM	1	65	01
27	F	HLT	F	12
28	RM	2	65	02
29	F	HLT	F	12
30	RM	3	65	03
31	F	HLT	F	12

STEP	KEY		KEY CODE	
32	RM	4	65	04
33	F	HLT	F	12
34	RM	5	65	05
35	F	HLT	F	12
36	RM	6	65	06
37		S/E		85
38	F	LBL	1	F	13	01
39	RM	1	65	01
40		÷		44
41	RM	t	65	83
42		=		84
43	x→M	7	55	07
44	RM	4	65	04
45		=		84
46	x→M	8	55	08
47	RM	t	65	83
48	F	1/x	F	43
49	x→M	9	55	09
50	RM	7	65	07
51		x		54
52	RM	s	65	82
53		−		64
54	RM	2	65	02
55		=		84
56		+/−		82
57	x→M	t	55	83
58	RM	8	65	08
59		x		54
60	RM	s	65	82
61		−		64
62	RM	5	65	05
63		=		84

MEMORY

s	√	4	√
t	√	5	√
0	√	6	√
1	√	7	√
2	√	8	√
3	√	9	√

LABEL

s		4	
t		5	
0		6	
1	√	7	
2		8	
3		9	

STEP	KEY		KEY CODE	
64		+/−	82	
65	x→M	1	55	01
66	RM	9	65	09
67		x	54	
68	RM	s	65	82
69		=	84	
70		+/−	82	
71	x→M	4	55	04
72	RM	0	65	00
73		x	54	
74	RM	7	65	07
75		−	64	
76	RM	3	65	03
77		=	84	
78		+/−	82	
79	x→M	s	55	82
80	RM	0	65	00
81		x	54	
82	RM	8	65	08
83		−	64	
84	RM	6	65	06
85		=	84	
86		+/−	82	
87	x→M	2	55	02
88	RM	0	65	00
89		x	54	
90	RM	9	65	09
91		=	84	
92		+/−	82	
93	x→M	5	55	05
94	RM	7	65	07
95	x→M	0	55	00

STEP	KEY		KEY CODE	
96	RM	8	65	08
97	x→M	3	55	03
98	RM	9	65	09
99	x→M	6	55	06
100		S/E		85
101				
102				
103				
104				
105				
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126				
127				

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2–A–12

TITLE PRODUCT OF TWO 2 x 2 MATRICES

[Formula]

This program computes the product of two 2 x 2 matrices shown as follows:

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}\begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix}=\begin{pmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{pmatrix} \qquad c_{11}=a_{11}\times b_{11}+a_{12}\times b_{21}$$

[Example]

$$\begin{pmatrix} 3 & 5 \\ 1 & 2 \end{pmatrix}\begin{pmatrix} -5 & 3 \\ 3 & -2 \end{pmatrix}=\begin{pmatrix} 0 & -1 \\ 1 & -1 \end{pmatrix}$$

$$\begin{pmatrix} -4 & -2 \\ 1 & 3 \end{pmatrix}\begin{pmatrix} -5 & 8 \\ 3 & 3 \end{pmatrix}=\begin{pmatrix} 14 & -38 \\ 4 & 17 \end{pmatrix}$$

[Operation] CA

(a_{11}) 3 S/E

(a_{21}) 1 S/E

(a_{12}) 5 S/E

(a_{22}) 2 S/E

(b_{11}) 5 +/− S/E

(b_{21}) 3 S/E

(b_{12}) 3 S/E

(b_{22}) 2 +/− S/E (c_{11}) 0

S/E (c_{21}) 1

S/E (c_{12}) −1

S/E (c_{22}) −1

STEP	KEY		KEY CODE	
0	x→M	t	55	83
1	F	HLT	F	12
2	x→M	s	55	82
3	F	HLT	F	12
4	x→M	0	55	00
5	F	HLT	F	12
6	x→M	1	55	01
7	F	HLT	F	12
8	x→M	2	55	02
9	F	HLT	F	12
10	x→M	3	55	03
11	F	HLT	F	12
12	x→M	4	55	04
13	F	HLT	F	12
14	x→M	5	55	05
15	RM	t	65	83
16		x		54
17	RM	2	65	02
18		+		74
19		(		42
20	RM	0	65	00
21		x		54
22	RM	3	65	03
23		)		43
24		=		84
25	x→M	6	55	06
26	F	HLT	F	12
27	RM	s	65	82
28		x		54
29	RM	2	65	02
30		+		74
31		(		42

STEP	KEY		KEY CODE	
32	RM	1	65	01
33		x		54
34	RM	3	65	03
35		)		43
36		=		84
37	x→M	7	55	07
38	F	HLT	F	12
39	RM	t	65	83
40		x		54
41	RM	4	65	04
42		+		74
43		(		42
44	RM	0	65	00
45		x		54
46	RM	5	65	05
47		)		43
48		=		84
49	x→M	8	55	08
50	F	HLT	F	12
51	RM	s	65	82
52		x		54
53	RM	4	65	04
54		+		74
55		(		42
56	RM	1	65	01
57		x		54
58	RM	5	65	05
59		)		43
60		=		84
61	x→M	9	55	09
62		S/E		85
63				

MEMORY

s	a_{21}	4	b_{12}
t	a_{11}	5	b_{22}
0	a_{12}	6	√
1	a_{22}	7	√
2	b_{11}	8	√
3	b_{21}	9	√

LABEL

s		4	
t		5	
0		6	
1		7	
2		8	
3		9	

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ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2–A–13

TITLE PRODUCT OF TWO 3 x 3 MATRICES

[Formula]

This program computes the product of two 3 x 3 matrices shown as follows:

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{pmatrix} = \begin{pmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{pmatrix}$$

$$c_{11}=a_{11}\times b_{11}+a_{12}\times b_{21}+a_{13}\times b_{31}$$

[Example]

$$\begin{pmatrix} 4 & -6 & -4 \\ -3 & 4 & -5 \\ 2 & -6 & 6 \end{pmatrix} \begin{pmatrix} 4 & 1 & 2 \\ 4-2 & -3 & \\ 1 & 1 & 1 \end{pmatrix} = \begin{pmatrix} -12 & 12 & 22 \\ -1 & -16 & -23 \\ -10 & 20 & 28 \end{pmatrix}$$

[Operation]

CA

(a_{11}) 4 S/E
(a_{21}) 3 +/− S/E
(a_{31}) 2 S/E
(a_{12}) 6 +/− S/E
(a_{22}) 4 S/E
(a_{32}) 6 +/− S/E
(a_{13}) 4 +/− S/E
(a_{23}) 5 +/− S/E
(a_{33}) 6 S/E
(b_{11}) 4 S/E
(b_{21}) 4 S/E
(b_{31}) 1 S/E (c_{11}) −12
S/E (c_{21}) −1
S/E (c_{31}) −10
(b_{12}) 1 S/E
(b_{22}) 2 +/− S/E
(b_{32}) 1 S/E (c_{12}) 12
S/E (c_{22}) −16
S/E (c_{32}) 20 *

*
(b_{13}) 2 S/E
(b_{23}) 3 +/− S/E
(b_{33}) 1 S/E (c_{13}) 22
S/E (c_{23}) −23
S/E (c_{33}) 28

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	t	55	83	32	RM	1	65	01
1	F	HLT	F	12	33		x		54
2	x→M	s	55	82	34	RM	8	65	08
3	F	HLT	F	12	35		)		43
4	x→M	0	55	00	36		+		74
5	F	HLT	F	12	37		(		42
6	x→M	1	55	01	38	RM	7	65	07
7	F	HLT	F	12	39		x		54
8	x→M	2	55	02	40	RM	t	65	83
9	F	HLT	F	12	41		)		43
10	x→M	3	55	03	42		=		84
11	F	HLT	F	12	43	F	HLT	F	12
12	x→M	4	55	04	44	RM	7	65	07
13	F	HLT	F	12	45		x		54
14	x→M	5	55	05	46	RM	s	65	82
15	F	HLT	F	12	47		+		74
16	x→M	6	55	06	48		(		42
17	F GTS	1	F 14	01	49	RM	8	65	08
18	F GTS	1	F 14	01	50		x		54
19	F GTS	1	F 14	01	51	RM	2	65	02
20		S/E		85	52		)		43
21	F LBL	1	F 13	01	53		+		74
22	F	HLT	F	12	54		(		42
23	x→M	7	55	07	55	RM	9	65	09
24	F	HLT	F	12	56		x		54
25	x→M	8	55	08	57	RM	5	65	05
26	F	HLT	F	12	58		)		43
27	x→M	9	55	09	59		=		84
28		x		54	60	F	HLT	F	12
29	RM	4	65	04	61	RM	7	65	07
30		+		74	62		x		54
31		(		42	63	RM	0	65	00

MEMORY				LABEL		
s	a_{11}, √	4	a_{13}, √	s		4
t	a_{11}, √	5	a_{23}, √	t		5
0	a_{21}, √	6	a_{33}, √	0		6
1	a_{12}, √	7	√	1	√	7
2	a_{22}, √	8	√	2		8
3	a_{32}, √	9	√	3		9

STEP	KEY		KEY CODE		STEP	KEY	KEY CODE
64		+		74	96		
65		(		42	97		
66	RM	8	65	08	98		
67		x		54	99		
68	RM	3	65	03	100		
69		)		43	101		
70		+		74	102		
71		(		42	103		
72	RM	9	65	09	104		
73		x		54	105		
74	RM	6	65	06	106		
75		)		43	107		
76		=		84	108		
77		S/E		85	109		
78					110		
79					111		
80					112		
81					113		
82					114		
83					115		
84					116		
85					117		
86					118		
87					119		
88					120		
89					121		
90					122		
91					123		
92					124		
93					125		
94					126		
95					127		

NOTE

SHARP

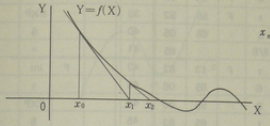
ANGLE DESIGNATION
DEG RAD GRAD

TITLE APPROXIMATING ROOT OF EQUATION (PART–I)

PROGRAM NO. P2–A–14

[Formula]

This program evaluates a root of the given equation by using "Newton's method".



$$x_{n+1}=x_n-\frac{f(x)}{f'(x)}$$

f' (x) is defined as follows:

$$f'(x)=\frac{f(x+h)-f(x)}{h}$$

A root is found when $|x_n-x_{n+1}|\leqq 10^{-5}$

[Example]

$$x^3-18.2x^2+109.4x-217=0$$

$x=5$ where $h=10^{-4}$ $x_0=1$

[Operation] CA

(h) EXP 4 +/– S/E

(x_0) 1 S/E (x) 5

Note: Before operation, the f(x) should be programmed as the second program. The value of f (x) should be stored in M6 (where M5 = x).

(Example)

f (x) = $x^3-18.2x^2+109.4x-217$

RUN-MODE GTO 2

PRO-MODE

If the calculator displays Error, retry changing x_0, h.

f (x) = ((x −18.2) x +109.4) x −217

RM 5	×
−	RM 5
18.2	−
×	217
RM 5	=
+	X→M 6
109.4	S/E

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		x→M	s	55	82	32		×	54
1		F	HLT	F	12	33	RM	s	65	82
2		x→M	t	55	83	34		−	64
3	F	LBL	3	F	13	03	35	RM	t	65	83
4		x→M	5	55	05	36		=	84
5	F	GTS	2	F	14	02	37		+/−	82
6	F	GTS	4	F	14	04	38		×	54
7	F	x≠0	s	F	55	82	39		EXP	41
8		RM	5	65	05	40		5	05
9			S/E		85	41		=	84
10	F	LBL	s	F	13	82	42	F	int	F	84
11		RM	6	65	06	43		÷	44
12		x→M	0	55	00	44		EXP	41
13		RM	t	65	83	45		5	05
14			+		74	46		=	84
15		RM	s	65	82	47		x→M	2	55	02
16			=		84	48	F	x=t	1	F	75	01
17		x→M	5	55	05	49		RM	2	65	02
18	F	GTS	2	F	14	02	50		x→M	t	55	83
19	F	GTS	4	F	14	04	51		GTO	3	14	03
20	F	x≠0	0	F	55	00	52	F	LBL	1	F	13	01
21		RM	5	65	05	53		RM	2	65	02
22			S/E		85	54			S/E		85
23	F	LBL	0	F	13	00	55	F	LBL	4	F	13	04
24		RM	6	65	06	56			x	54
25		x→M	1	55	01	57			EXP	41
26			÷		44	58			9	09
27		RM	0	65	00	59			=	84
28			−		64	60		F	int	F	84
29			1		01	61			S/E		85
30			=		84	62	F	LBL	2	F	13	02
31		F	1/x	F	43	63					

MEMORY

s	h	4	
t	x_n	5	x
0	$f(x)$	6	$f(x)$
1	$f(x+h)$	7	
2	x_{n+1}	8	
3		9	

LABEL

s	√	4	√
t		5	
0	√	6	
1	√	7	
2	√	8	
3	√	9	

SHARP

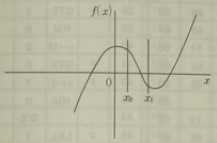
ANGLE DESIGNATION
DEG RAD GRAD

TITLE APPROXIMATING ROOT OF EQUATION (PART–II)

PROGRAM NO. P2–A–15

[Formula]

A twofold partition Method.



[Example]

Find a root of $f(x)=x^3-2x^2-x+2$

Solution: $x = 1$(where initial condition $x_0=0.5$, $x_1=1.2$)

[Operation]

CA

(x_0) 0.5 S/E

(x_1) 1.2 S/E (x)9.999999993×10⁻¹

A root is found when $|x_n-x_{n+1}|<10^{-9}$

Note: Before operation, the f(x) should be programmed as the second program. The value of f(x) should be stored in M6 (where M5 = x).

(Example)

In the case of $f(x)=x^3-2x^2-x+2$

RUN-MODE GTO 2

PRO-MODE

RM 5	×	2
×	RM5	=
RM 5	×	X→M6
×	RM5	S/E
RM 5	)	
−		
(	RM5	
2	+	

STEP	KEY		KEY CODE		
0		x→M	t	55	83
1		F	HLT	F	12
2		x→M	s	55	82
3		RM	t	65	83
4		x→M	5	55	05
5	F	GTS	2	F 14	02
6		RM	6	65	06
7		x→M	7	55	07
8	F	GTS	0	F 14	00
9	F	x≠0	5	F 55	05
10		RM	t	65	83
11			S/E		85
12	F	LBL	5	F 13	05
13		RM	s	65	82
14		x→M	5	55	05
15	F	GTS	2	F 14	02
16		RM	6	65	06
17		x→M	8	55	08
18			x		54
19		RM	7	65	07
20			=		84
21	F	GTS	0	F 14	00
22	F	x≠0	6	F 55	06
23		RM	s	65	82
24			S/E		85
25	F	LBL	6	F 13	06
26	F	x<0	3	F 65	03
27			C·CE		35
28			S/E		85
29	F	LBL	3	F 13	03
30		RM	t	65	83
31			+		74

STEP	KEY		KEY CODE		
32		RM	s	65	82
33			÷		44
34			2		02
35			=		84
36		x→M	0	55	00
37		x→M	5	55	05
38	F	GTS	2	F 14	02
39		RM	6	65	06
40		x→M	9	55	09
41	F	GTS	0	F 14	00
42	F	x≠0	7	F 55	07
43		RM	0	65	00
44			S/E		85
45	F	LBL	7	F 13	07
46		RM	9	65	09
47			x		54
48		RM	7	65	07
49			=		84
50	F	x<0	4	F 65	04
51		RM	0	65	00
52		x→M	t	55	83
53		GTO	3	14	03
54	F	LBL	4	F 13	04
55		RM	0	65	00
56		x→M	s	55	82
57		GTO	3	14	03
58	F	LBL	0	F 13	00
59			x		54
60			EXP		41
61			9		09
62			=		84
63		F	int	F	84

MEMORY

s	x_1	4	
t	x_2	5	x
0	$(x_1+x_2)/2$	6	$f(x)$
1		7	$f(x_s)$
2		8	$f(x_t)$
3		9	$f((x_s+x_t)/2)$

LABEL

s		4	√
t		5	√
0	√	6	√
1		7	√
2	√	8	
3	√	9	

STEP	KEY		KEY CODE		
64			S/E	85	
65	F	LBL	2	F 13	02
66					
67					
68					
69					
70					
71					
72					
73					
74					
75					
76					
77					
78					
79					
80					
81					
82					
83					
84					
85					
86					
87					
88					
89					
90					
91					
92					
93					
94					
95					

STEP	KEY	KEY CODE
96		
97		
98		
99		
100		
101		
102		
103		
104		
105		
106		
107		
108		
109		
110		
111		
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NOTE

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TITLE NUMERICAL INTEGRATION (SIMPSON'S RULE)

PROGRAM NO. P2–A–16

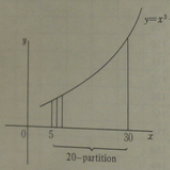
[Formula]

$$S=\int_{x_0}^{x_{2p}} f(x)dx=\frac{h}{3}\{(y_0+y_{2p})+4(y_1+y_3+\cdots\cdots+y_{2p-1})+2(y_2+y_4+\cdots\cdots+y_{2p-2})\}$$

$$h=\frac{(x_{2p}-x_0)}{2p}$$

P: The number of partition

[Example]



Note: Before operation, the f (x) should be programmed as the second program. The value of f (x) should be stored in M6 (where M5 = x).

(Example)

f (x)=x³−2x²−x+2

RUN-MODE GTO 2

PRO-MODE

RM5 × RM5 × RM5 − (2 × RM5 × RM5 − 2 = X→M6 S/E

[Operation] CA

(x_0) 5 S/E

(x_{2p}) 30 S/E

(p) 20 S/E 184039.5833

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
0		x→M	1	55	01	32			×		54
1		F	HLT	F	12	33			4		04
2		x→M	s	55	82	34		M+	9	75	09
3		F	HLT	F	12	35			2		02
4		x→M	t	55	83	36			×		54
5			×		54	37		RM	0	65	00
6			2		02	38			+		74
7			÷		44	39		RM	1	65	01
8			(		42	40			=		84
9		RM	s	65	82	41		x→M	5	55	05
10			−		64	42		x→M	1	55	01
11		RM	1	65	01	43	F	GTS	2	14	02
12			)		43	44		RM	6	65	06
13			↕		45	45		M+	9	75	09
14			=		84	46			1		01
15		x→M	0	55	00	47			+/−		82
16			0		00	48		M+	t	75	83
17		x→M	8	55	08	49		RM	t	65	83
18		x→M	9	55	09	50	F	x≠0	1	55	01
19	F	LBL	1	13	01	51		RM	9	65	09
20		RM	1	65	01	52			×		54
21		x→M	5	55	05	53		RM	0	65	00
22	F	GTS	2	14	02	54			÷		44
23		RM	6	65	06	55			3		03
24		M+	9	75	09	56			=		84
25		RM	1	65	01	57			S/E		85
26			+		74	58	F	LBL	2	13	02
27		RM	0	65	00	59					
28			=		84	60					
29		x→M	5	55	05	61					
30	F	GTS	2	14	02	62					
31		RM	6	65	06	63					

MEMORY			
s	x_{2p}	4	
t	x_0	5	
0	h	6	
1	p	7	
2		8	
3		9	

LABEL			
s		4	
t		5	
0		6	
1	√	7	
2	√	8	
3		9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2-A-17

TITLE **FRESNEL'S INTEGRAL**

[Formula]

S(x): A sine integration, C(x): A cosine integration

$$S(x)=\int_0^x \sin\frac{\pi t^2}{2}dt=\sum_{n=0}^{\infty}\frac{(-1)^n\left(\frac{\pi}{2}\right)^{2n+1}}{(2n+1)!(4n+3)}x^{4n+3}$$

$$C(x)=\int_0^x \cos\frac{\pi t^2}{2}dt=\sum_{n=0}^{\infty}\frac{(-1)^n\left(\frac{\pi}{2}\right)^{2n}}{(2n)!(4n+1)}x^{4n+1}$$

$$\lim_{x\to\infty} C(x)=\lim_{x\to\infty} S(x)=\frac{1}{2}$$

$$C(-x)=-C(x)$$

$$S(-x)=-S(x)$$

[Example]

C(0.5) = 0.492344·····

C(1.0) = 0.779893·····

S(0.5) = 0.064732·····

S(3.0) = 0.496312·····

[Operation]

A cosine integration,

(x) 0.5 GTO 1 S/E $C(x)=4.923442258\times10^{-1}$

(x) 1.0 GTO 1 S/E $C(x)=7.798934003\times10^{-1}$

A sine integration,

(x) 0.5 GTO 2 S/E $S(x)=6.473243285\times10^{-2}$

(x) 3.0 GTO 2 S/E $S(x)=4.963053272\times10^{-1}$

STEP	KEY		KEY CODE			STEP	KEY		KEY CODE		
0	F	LBL	1	F	13	01	32		F	x^3		F	44
1		x→M	t		55	83	33		x→M	3		55	03
2		x→M	5		55	05	34			2			02
3		x→M	9		55	09	35		x→M	0		55	00
4		F	x^2		F	44	36		RM	t		65	83
5		F	x^2		F	44	37		F	x^2		F	44
6		x→M	4		55	04	38			x			54
7		F	π		F	41	39		RM	t		65	83
8			÷			44	40			÷			44
9			2			02	41			3			03
10			=			84	42		x→M	1		55	01
11		F	x^3		F	44	43			=			84
12		x→M	3		55	03	44		x→M	5		55	05
13			1			01	45		x→M	9		55	09
14		x→M	0		55	00	46	F	LBL	3	F	13	03
15		x→M	1		55	01	47	F	GTS	4	F	14	04
16	F	LBL	6	F	13	06	48	F	GTS	5	F	14	05
17	F	GTS	4	F	14	04	49	F	$x\neq0$	3	F	55	03
18			=			84	50		RM	9		65	09
19	F	GTS	5	F	14	05	51			x			54
20	F	$x\neq0$	6	F	55	06	52		F	π		F	41
21		RM	9		65	09	53			÷			44
22			S/E			85	54			2			02
23	F	LBL	2	F	13	02	55			=			84
24		x→M	t		55	83	56			S/E			85
25		F	x^3		F	44	57	F	LBL	4	F	13	04
26		F	x^2		F	44	58		RM	1		65	01
27		x→M	4		55	04	59			+			74
28		F	π		F	41	60			4			04
29			÷			44	61			=			84
30			2			02	62		x→M	2		55	02
31			=			84	63		RM	3		65	03

MEMORY					LABEL				
s		4	x^4		s		4	√	
t	x	5	√		t		5	√	
0	√	6			0		6	√	
1	√	7			1	√	7		
2	√	8			2	√	8		
3	$(\frac{\pi}{2})^3$	9	Σ		3	√	9		

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64		x		54	96		S/E		85					
65	RM	4	65	04	97									
66		x		54	98									
67	RM	1	65	01	99									
68		÷		44	100									
69	RM	2	65	02	101									
70		÷		44	102									
71	RM	0	65	00	103									
72		÷		44	104									
73		(		42	105									
74	RM	0	65	00	106									
75		+		74	107									
76		1		01	108									
77		)		43	109									
78		S/E		85	110									
79	F LBL	5	F	13	05	111								
80		x		54	112									
81	RM	5	65	05	113									
82		=		84	114									
83		+/−		82	115									
84	x→M	5	55	05	116									
85	M+	9	75	09	117									
86		2		02	118									
87	M+	0	75	00	119									
88		4		04	120									
89	M+	1	75	01	121									
90	RM	5	65	05	122									
91		x		54	123									
92		EXP		41	124									
93		9		09	125									
94		=		84	126									
95	F	int	F	84	127									

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE BESSEL FUNCTION OF THE FIRST KIND

PROGRAM NO. P2–A–18

[Formula]

◎ The bessel function of the first kind of order zero

$$J_0(x)=\sum_{k=0}^{\infty}\frac{\left(\frac{-x^2}{2}\right)^k}{k!\,3\cdot 5\cdots(2k+1)}=1-\frac{1}{3}\left(\frac{x^2}{2}\right)+\frac{1}{2!\cdot 3\cdot 5}\left(\frac{x^2}{2}\right)^2-\cdots\cdots$$

◎ The bessel function of the first kind of order n

$$J_n(x)=\frac{x^n}{1\cdot 3\cdot 5\cdots(2n+1)}\sum_{k=0}^{\infty}\frac{\left(-\frac{x^2}{2}\right)^k}{k!(2n+3)\cdots(2n+2k+1)}$$

$$=\frac{x^n}{1\cdot 3\cdot 5\cdots(2n+1)}\left\{1-\frac{\left(\frac{x^2}{2}\right)}{1!(2n+3)}+\frac{\left(\frac{x^2}{2}\right)^2}{2!(2n+3)(2n+5)}-\cdots\cdots\right\}$$

[Example]

$J_0(0.5)=0.95885107$

$J_0(1)=0.84147098$

$J_2(2)=0.19844794$

$J_3(2)=0.06072209$

[Operation]

Order zero.

(x) 0.5 GTO 1 S/E $J_0(0.5)=9.588510772\times10^{-1}$

(x) 1 GTO 1 S/E $J_0(1)=8.414709847\times10^{-1}$

Order n.

(n) 2 GTO 2 S/E

(x) 2 S/E $J_2(2)=1.672790078\times10^{-1}$

(n) 3 GTO 2 S/E

(x) 2 S/E $J_3(2)=5.531942444\times10^{-2}$

STEP	KEY			KEY CODE		
0	F	LBL	1	F	13	01
1		x→M	t		55	83
2		F	x^2	F	44	
3			÷			44
4			2			02
5			=			84
6		x→M	s		55	82
7			1			01
8		x→M	9		55	09
9			2			02
10		x→M	1		55	01
11			5			05
12		x→M	2		55	02
13		RM	s		65	82
14			÷			44
15			3			03
16			=			84
17			+/–			82
18		x→M	5		55	05
19		M+	9		75	09
20	F	LBL	3	F	13	03
21		RM	s		65	82
22			÷			44
23		RM	1		65	01
24			÷			44
25		RM	2		65	02
26			x			54
27		RM	5		65	05
28			=			84
29			+/–			82
30		x→M	5		55	05
31		M+	9		75	09

MEMORY			
s	$x^2/2$, x	4	2n
t	x, n	5	√
0		6	Σ
1	√	7	√
2	√	8	√
3	$x^2/2$	9	Σ

STEP	KEY			KEY CODE		
32	F	GTS	0	F	14	00
33	F	x≠0	3	F	55	03
34		RM	9		65	09
35			S/E			85
36	F	LBL	2	F	13	02
37		x→M	s		55	82
38		F	HLT		F	12
39		x→M	t		55	83
40			y^x			31
41		RM	s		65	82
42			=			84
43		x→M	9		55	09
44		RM	s		65	82
45			x			54
46			2			02
47			+			74
48			1			01
49			=			84
50		x→M	8		55	08
51		x→M	7		55	07
52	F	LBL	4	F	13	04
53			2			02
54			+/–			82
55		M+	7		75	07
56		RM	7		65	07
57			x			54
58		RM	8		65	08
59			=			84
60		x→M	8		55	08
61		RM	7		65	07
62			–			64
63			1			01

LABEL			
s		4	√
t		5	√
0	√	6	
1	√	7	
2	√	8	
3	√	9	

STEP	KEY			KEY CODE		
64		=			84	
65	F	x≠0	4	F	55	04
66			1		01	
67		x→M	6		55	06
68		RM	t		65	83
69		F	x^2		F	44
70			÷			44
71			2			02
72			=			84
73		x→M	3		55	03
74		RM	s		65	82
75			x			54
76			2			02
77			=			84
78		x→M	4		55	04
79		RM	4		65	04
80			+			74
81		RM	3		65	03
82			÷			44
83		RM	3		65	03
84			‡			45
85			=			84
86			+/–			82
87		x→M	5		55	05
88		M+	6		75	06
89			5			05
90		x→M	2		55	02
91			2			02
92		x→M	1		55	01
93	F	LBL	5	F	13	05
94		RM	3		65	03
95			÷			44

STEP	KEY			KEY CODE		
96		RM	1		65	01
97			÷			44
98			(			42
99		RM	4		65	04
100			+			74
101		RM	2		65	02
102			)			43
103			x			54
104		RM	5		65	05
105		M+	6		75	06
106		x→M	5		55	05
107	F	GTS	0	F	14	00
108	F	x≠0	5	F	55	05
109		RM	6		65	06
110			x			54
111		RM	9		65	09
112			÷			44
113		RM	8		65	08
114			=			84
115			S/E			85
116	F	LBL	0	F	13	00
117			1			01
118		M+	1		75	01
119			2			02
120		M+	2		75	02
121		RM	5		65	05
122			x			54
123			EXP			41
124			9			09
125			=			84
126		F	int		F	84
127			S/E			85

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE ERROR FUNCTION & INVERSE ERROR FUNCTION

PROGRAM NO.
P2-A-19

[Formula]

(1) Error function

$$erf(x)=\frac{2}{\sqrt{\pi}}\int_0^x e^{-t}dt$$

$$=\frac{2}{\sqrt{\pi}}\left(x-\frac{x^3}{3}+\frac{x^5}{2!5}-\frac{x^7}{3!7}+\cdots\cdots\right) \qquad (x \geqq 0)$$

(2) Inverse error function

$$x(q)=\left(y-\left(a_1-\frac{a_2}{y+a_3}\right)\right)^{\frac{1}{2}}$$

$$\begin{cases} a_1=2.0611786 \\ a_2=5.7262204 \\ a_3=11.640595 \\ y=-\ln 4\,q\,(1-q) \end{cases} \qquad (0<q\leqq 0.5)$$

[Example]

(1) $erf(0.5)=0.52049987\cdots\cdots$

$erf(1)=0.84270079\cdots\cdots$

(2) $x(0.5)=0$

$x(0.42074)=0.2$

[Operation]

(1) CA

(x)0.5 S/E 5.204998778×10⁻¹

(x)1 S/E 8.427007929×10⁻¹

(2) (q) 0.5 GTO 2 S/E 0

(q) 0.42074 GTO 2 S/E 1.999112909×10⁻¹

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
0		x→M	t	55	83	32			+/–		82
1			0		00	33		x→M	4	55	04
2		x→M	0	55	00	34		RM	2	65	02
3		x→M	3	55	03	35			x		54
4			1		01	36			EXP		41
5		x→M	1	55	01	37			9		09
6		x→M	4	55	04	38			=		84
7	F	LBL	0	F 13	00	39		F	int	F	84
8		RM	0	65	00	40	F	$x\neq 0$	0	F 55	00
9		F	n!	F	54	41		F	π	F	41
10			×		54	42		F	√	F	42
11		RM	1	65	01	43			÷		44
12			=		84	44			2		02
13		x→M	s	55	82	45			↕		45
14		RM	t	65	83	46			x		54
15	F	$x\neq 0$	3	F 55	03	47		RM	3	65	03
16			S/E		85	48			=		84
17	F	LBL	3	F 13	03	49			S/E		85
18			y^x		31	50	F	LBL	2	F 13	02
19		RM	1	65	01	51		x→M	4	55	04
20			÷		44	52			–		64
21		RM	s	65	82	53			1		01
22			x		54	54			↕		45
23		RM	4	65	04	55			x		54
24			=		84	56			4		04
25		x→M	2	55	02	57			x		54
26		M+	3	75	03	58		RM	4	65	04
27			1		01	59			=		84
28		M+	0	75	00	60			ln		33
29			2		02	61			+/–		82
30		M+	1	75	01	62		x→M	5	55	05
31		RM	4	65	04	63			+		74

MEMORY				LABEL			
s	√	4	√, q	s			4
t	x	5	√	t			5
0	√	6		0	√		6
1	√	7		1			7
2	√	8		2	√		8
3	√	9		3	√		9

STEP	KEY	KEY CODE	STEP	KEY	KEY CODE
64	1	01	96	RM	5	65	05
65	1	01	97	=	84
66	.	83	98	F	√	F	42
67	6	06	99	S/E	85
68	4	04	100		
69	0	00	101		
70	5	05	102		
71	9	09	103		
72	5	05	104		
73	÷	44	105		
74	5	05	106		
75	.	83	107		
76	7	07	108		
77	2	02	109		
78	6	06	110		
79	2	02	111		
80	2	02	112		
81	0	00	113		
82	4	04	114		
83	‡	45	115		
84	−	64	116		
85	2	02	117		
86	.	83	118		
87	0	00	119		
88	6	06	120		
89	1	01	121		
90	1	01	122		
91	7	07	123		
92	8	08	124		
93	6	06	125		
94	‡	45	126		
95	x	54	127		

NOTE

SHARP

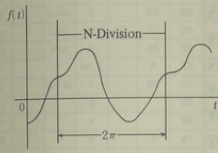
ANGLE DESIGNATION
DEG (RAD) GRAD

TITLE **FOURIER SERIES**

PROGRAM NO.
P2−A−20

[Formula]

This program expands a frequent function f(x) in Fourier series. (where $f(t)=f(t+2\pi)$, t: variable)



$$f(t)=\frac{a_0}{2}+\sum_{n=1}^{\infty}(a_n\cos nt+b_n\sin nt)$$

$$a_i=\frac{2}{N}\sum_{n=1}^{N}y_n\cos\left(\frac{2\pi}{N}\cdot nj\right)$$

$$b_i=\frac{2}{N}\sum_{n=1}^{N}y_n\sin\left(\frac{2\pi}{N}\cdot nj\right)$$

[Example]

n	$f(t)$	n	$f(t)$	n	$f(t)$
1	8.729771	5	1	9	−8.111737
2	−2.070344	6	−8.11173	10	1
3	−2.070341	7	0.45231		
4	8.729764	8	0.45231		

$a_0=3\times10^{-7}$ $a_1=-1.84\times10^{-7}$ $a_2=1$

$a_3=4.85\times10^{-7}$ $a_4=1.8\times10^{-7}$ $a_5=-3\times10^{-7}$

$b_1=3$ $b_2=2.3\times10^{-6}$ $b_3=7$

$b_4=2.2\times10^{-6}$

SHARP

ANGLE DESIGNATION
DEG (RAD) GRAD

TITLE **FOURIER SERIES**

PROGRAM NO. P2–A–20

[Operation]

CA

i) (N) 10 S/E

→ ii) (j) 1 S/E

$(f(t)_1)$ 8.729771 S/E

$(f(t)_2)$ 2.070344 +/− S/E

$(f(t)_3)$ 2.070341 +/− S/E

$(f(t)_4)$ 8.729764 S/E

$(f(t)_5)$ 1 S/E

$(f(t)_6)$ 8.11173 +/− S/E

$(f(t)_7)$ 0.45231 S/E

$(f(t)_8)$ 0.45231 S/E

$(f(t)_9)$ 8.111737 +/− S/E

$(f(t)_{10})$ 1 S/E

GTO 2 S/E (a_1) -1.842×10^{-7}

S/E (b_1) 3.000000327

Repeat

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	t	55	83	32	M+	6	75	06
1	F LBL	t	F 13	83	33		1		01
2	F	HLT	F	12	34	M+	0	75	00
3	x→M	s	55	82	35	GTO	0	14	00
4		1		01	36	F LBL	2	F 13	02
5	x→M	0	55	00	37	RM	5	65	05
6		0		00	38		x		54
7	x→M	5	55	05	39		2		02
8	x→M	6	55	06	40		÷		44
9	F LBL	0	F 13	00	41	RM	t	65	83
10	RM	0	65	00	42		=		84
11	F	HLT	F	12	43	F	HLT	F	12
12	x→M	1	55	01	44	RM	6	65	06
13		2		02	45		x		54
14		x		54	46		2		02
15	F	π	F	41	47		÷		44
16		x		54	48	RM	t	65	83
17	RM	s	65	82	49		=		84
18		x		54	50	GTO	t	14	83
19	RM	0	65	00	51				
20		÷		44	52				
21	RM	t	65	83	53				
22		=		84	54				
23	x→M	2	55	02	55				
24		cos		23	56				
25		x		54	57				
26	RM	1	65	01	58				
27	M+	5	75	05	59				
28	RM	2	65	02	60				
29		sin		22	61				
30		x		54	62				
31	RM	1	65	01	63				

MEMORY			
s	/	4	
t	N	5	*aj*
0	count	6	*bj*
1	*yi*	7	
2	*θ*	8	
3		9	

LABEL		
s		4
t	√	5
0	√	6
1		7
2	√	8
3		9

SHARP PROGRAM LIBRARY

ANGLE DESIGNATION: DEG RAD GRAD

TITLE FIRST ORDER DIFFERENCIAL EQUATION

PROGRAM NO. P2–A–21 A–22

[Formula]

$\frac{dy}{dx} = f(x, y)$ Initial condition $x = x_0$ $y = y_0$

$x_n = x_0 + nh$ (n = 1, 2, 3, 4, ·····)

(1) Runge Kutta Method (P 2 – A – 21)

$$y_{n+1} = y_n + (k_1 + 2k_2 + 2k_3 + k_4)/6$$

$$\begin{cases} k_1 = h\, f(x_n, y_n) \\ k_2 = h\, f(x_n + h/2,\ y_n + k_1/2) \\ k_3 = h\, f(x_n + h/2,\ y_n + k_2/2) \\ k_4 = h\, f(x_n + h,\ y_n + k_3) \end{cases}$$

(2) Runge Kutta Gill Method (P 2 – A –22)

$k_0 = h\, f(x_n, y_n)$

$y_1 = y_n + \frac{1}{2}(k_0 - 2q_0)$, $q_1 = q_0 + 3[\frac{1}{2}(k_0 - 2q_0)] - \frac{1}{2}k_0$

$k_1 = h\, f(x_n + h/2,\ y_1)$

$y_2 = y_1 + (1 - \sqrt{\frac{1}{2}})(k_1 - q_1)$

$q_2 = q_1 + 3[(1 - \sqrt{\frac{1}{2}})(k_1 - q_1)] - (1 - \sqrt{\frac{1}{2}})k_1$

$k_2 = h\, f(x_n + h/2,\ y_2)$

$y_3 = y_2 + (1 + \sqrt{\frac{1}{2}})(k_2 - q_2)$

$q_3 = q_2 + 3[(1 + \sqrt{\frac{1}{2}})(k_2 - q_2)] - (1 + \sqrt{\frac{1}{2}})k_2$

$k_3 = h\, f(x_n + h,\ y_3)$

$y_4 = \frac{1}{6}(k_3 - 2q_3)$

$q_4 = q_3 + 3[\frac{1}{6}(k_3 - 2q_3)] - \frac{1}{2}k_3$

Initial $q_0 = 0$,

The new q_0 = last q_4.

SHARP

ANGLE DESIGNATION: DEG RAD GRAD

TITLE FIRST ORDER DIFFERENCIAL EQUATION

PROGRAM NO. P2–A–21 A–22

[Example]

(1) $\frac{dy}{dx} = x + y$ $(x_0 = y_0 = 0,\ h = 0.5)$

x	Runge Kutta	Runge Kutta Gill	true value
0.5	0.1484375	0.1484375	0.148721271·····
1	$7.173461915 \times 10^{-1}$	$7.173461914 \times 10^{-1}$	0.718281828·····
1.5	1.979375362	1.979375362	1.98168907 ·····
2	4.383970324	4.383970324	4.389056099·····
2.5	8.672013582	8.672013581	8.68249396 ·····
3	16.06480364	16.06480363	16.08553692 ·····

(2) $\frac{dy}{dx} = x + 1$ $(x_0 = y_0 = 0,\ h = 1)$

x	Runge Kutta	Runge Kutta Gill	true value
1	1.5	1.5	1.5
2	4	4	4
3	7.5	7.5	7.5
4	12	11.99999999	12
5	17.5	17.49999999	17.5
6	24	24	24

(P 2 – A – 21), (P 2 – A –22) is equal.

[Operation]

(Ex. 1)

		CA
(x_0)	0	S/E
(y_0)	0	S/E
(h)	0.5	S/E
		(x) 0.5
		S/E
		(y) 0.1484375
		S/E
		(x) 1
		S/E
		(y) $7.173461915 \times 10^{-1}$

Note: Before operation, the f (x, y) should be programmed as the second program. The value of $\frac{dy}{dx}$ should be stored in M7 (where M5 = x, M6 = y).

(Example) The $\frac{dy}{dx} = x + y$ is operated as follws.

RUN-MODE, GTO 2

PRO-MODE

RM 5 → = → X→M7

RM 6 → + → S/E

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
0		x→M	t	55	83	32		RM	0	65	00
1		F	HLT	F	12	33			=		84
2		x→M	s	55	82	34		x→M	2	55	02
3		F	HLT	F	12	35			÷		44
4		x→M	0	55	00	36			2		02
5	F	LBL	t	F 13	83	37			+		74
6		RM	t	65	83	38		RM	s	65	82
7		x→M	5	55	05	39			=		84
8		RM	s	65	82	40		x→M	6	55	06
9		x→M	6	55	06	41	F	GTS	2	F 14	02
10	F	GTS	2	F 14	02	42		RM	7	65	07
11		RM	7	65	07	43			x		54
12			x		54	44		RM	0	65	00
13		RM	0	65	00	45			=		84
14			=		84	46		x→M	3	55	03
15		x→M	1	55	01	47			+		74
16			÷		44	48		RM	s	65	82
17			2		02	49			=		84
18			+		74	50		x→M	6	55	06
19		RM	s	65	82	51		RM	0	65	00
20			=		84	52		M+	t	75	83
21		x→M	6	55	06	53		RM	t	65	83
22		RM	0	65	00	54		x→M	5	55	05
23			÷		44	55	F	GTS	2	F 14	02
24			2		02	56		RM	7	65	07
25			+		74	57			x		54
26		RM	t	65	83	58		RM	0	65	00
27			=		84	59			=		84
28		x→M	5	55	05	60		x→M	4	55	04
29	F	GTS	2	F 14	02	61		RM	2	65	02
30		RM	7	65	07	62			+		74
31			x		54	63		RM	3	65	03

MEMORY

s	y_0	4	k_4
t	x_0	5	x
0	h	6	y
1	k_1	7	$f'(x, y)$
2	k_2	8	
3	k_3	9	

LABEL

s		4	
t	√	5	
0		6	
1		7	
2	√	8	
3		9	

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
64			x		54	96					
65			2		02	97					
66			+		74	98					
67		RM	1	65	01	99					
68			+		74	100					
69		RM	4	65	04	101					
70			÷		44	102					
71			6		06	103					
72		M+	s	75	82	104					
73		RM	t	65	83	105					
74		F	HLT	F	12	106					
75		RM	s	65	82	107					
76		F	HLT	F	12	108					
77		GTO	t	14	83	109					
78	F	LBL	2	F 13	02	110					
79						111					
80						112					
81						113					
82						114					
83						115					
84						116					
85						117					
86						118					
87						119					
88						120					
89						121					
90						122					
91						123					
92						124					
93						125					
94						126					
95						127					

NOTE

Runge-Kutta Method

Program No.

P2–A–21

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
0		x→M	t	55	83	32		RM	0	65	00
1		F	HLT	F	12	33			÷		44
2		x→M	s	55	82	34			2		02
3		F	HLT	F	12	35		M+	t	75	83
4		x→M	0	55	00	36		RM	t	65	83
5			0		00	37		x→M	5	55	05
6		x→M	1	55	01	38	F	GTS	2	F 14	02
7	F	LBL	t	F 13	83	39	F	GTS	4	F 14	04
8		RM	t	65	83	40			6		06
9		x→M	5	55	05	41	F	GTS	5	F 14	05
10		RM	s	65	82	42		RM	t	65	83
11		x→M	6	55	06	43		F	HLT	F	12
12	F	GTS	2	F 14	02	44		RM	s	65	82
13	F	GTS	4	F 14	04	45		F	HLT	F	12
14			2		02	46		GTO	t	14	83
15	F	GTS	5	F 14	05	47	F	LBL	3	F 13	03
16		RM	0	65	00	48			·		83
17			÷		44	49			5		05
18			2		02	50		F	√‾	F	42
19		M+	t	75	83	51			=		84
20		RM	t	65	83	52		x→M	9	55	09
21		x→M	5	55	05	53		RM	7	65	07
22		RM	s	65	82	54			x		54
23		x→M	6	55	06	55		RM	0	65	00
24	F	GTS	2	F 14	02	56			=		84
25			1		01	57		x→M	8	55	08
26			–		64	58			–		64
27	F	GTS	3	F 14	03	59		RM	1	65	01
28	F	GTS	2	F 14	02	60			x		54
29			1		01	61		RM	9	65	09
30			+		74	62		M+	s	75	82
31	F	GTS	3	F 14	03	63			x		54

MEMORY

s	y_e, √	4	
t	x_e, √	5	x
0	h	6	y
1	√	7	dy/dx
2		8	√
3		9	√

LABEL

s		4	√
t	√	5	√
0		6	
1		7	
2	√	8	
3	√	9	

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
64			3		03	96			2		02
65		M+	1	75	01	97			)		43
66		RM	9	65	09	98		M+	1	75	01
67			+/–		82	99			S/E		85
68			x		54	100	F	LBL	2	F 13	02
69		RM	8	65	08	101					
70		M+	1	75	01	102					
71		RM	s	65	82	103					
72		x→M	6	55	06	104					
73			S/E		85	105					
74	F	LBL	4	F 13	04	106					
75		RM	7	65	07	107					
76			x		54	108					
77		RM	0	65	00	109					
78			=		84	110					
79		x→M	8	55	08	111					
80			–		64	112					
81			(		42	113					
82			2		02	114					
83			x		54	115					
84		RM	1	65	01	116					
85			)		43	117					
86			÷		44	118					
87			S/E		85	119					
88	F	LBL	5	F 13	05	120					
89		M+	s	75	82	121					
90			x		54	122					
91			3		03	123					
92			–		64	124					
93			(		42	125					
94		RM	8	65	08	126					
95			÷		44	127					

NOTE

Runge-Kutta-Gill Method

Program No.

P2–A–22.

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **POISSON DISTRIBUTION**

PROGRAM NO. P2-8-1

[Formula]

This program calculates the probability of poisson distribution and the sum of the probability. (where $i = 0 \sim x$)

Probability: $P = \frac{e^{-m} m^x}{x!}$

Sum: $L = \sum_{i=0}^{x} P_i$

[Example]

$m = 3$, $x = 4$

[Operation]

CA

(m) 3 S/E

(x) 4 S/E (P) $1.680313558 \times 10^{-1}$

S/E (L) $8.152632446 \times 10^{-1}$

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	0	55	00	32	RM	2	65	02
1		+/–	82		33	F $x \neq 0$	1	F 55	01
2		e^x	32		34	RM	4	65	04
3	x→M	3	55	03	35	S/E			85
4	F	HLT	F	12	36				
5	x→M	1	55	01	37				
6	x→M	2	55	02	38				
7	F	n!	F	54	39				
8	x→M	4	55	04	40				
9	RM	0	65	00	41				
10		y^x		31	42				
11	RM	1	65	01	43				
12		×		54	44				
13	RM	3	65	03	45				
14		÷		44	46				
15	RM	4	65	04	47				
16		=		84	48				
17	x→M	3	55	03	49				
18	x→M	4	55	04	50				
19	x→M	5	55	05	51				
20	F	HLT	F	12	52				
21	F LBL	1	F 13	01	53				
22	RM	5	65	05	54				
23		×		54	55				
24	RM	2	65	02	56				
25		÷		44	57				
26	RM	0	65	00	58				
27	M+	4	75	04	59				
28	x→M	5	55	05	60				
29		1		01	61				
30		+/–		82	62				
31	M+	2	75	02	63				

MEMORY				LABEL			
s		4	L	s		4	
t		5	P_i	t		5	
0	m	6		0		6	
1	x	7		1		7	
2	i	8		2		8	
3	P	9		3		9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **NORMAL DISTRIBUTION**

PROGRAM NO. P2-B-2

[Formula]

The following normal distribution function $\phi(x)$ is determined by the use of Hastings' best approximate equation.

$$\phi(x) = \int_{-\infty}^{t} \phi_1 \, dx$$

$$\phi_1 = \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}}$$

$$t = \frac{1}{1+px}$$

$$\phi(x) \fallingdotseq 1 - \phi_1 (c_1 t + c_2 t^2 + c_3 t^3 + c_4 t^4 + c_5 t^5)$$

$P = 0.2316419$

$c_1 = 0.31938153$

$c_2 = -0.356563782$

$c_3 = 1.78147937$

$c_4 = -1.821255978$

$c_5 = 1.330274429$

[Example]

$x = 1.2,\ 2.5$

[Operation]

CA

(x) 1.2 S/E (ϕ) $8.849301351 \times 10^{-1}$

(x) 2.5 S/E (ϕ) $9.937903137 \times 10^{-1}$

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	1	55	01	32		x		54
1		x		54	33		·		83
2		·		83	34		3		03
3		2		02	35		1		01
4		3		03	36		9		09
5		1		01	37		3		03
6		6		06	38		8		08
7		4		04	39		1		01
8		1		01	40		5		05
9		9		09	41		3		03
10		+		74	42		=		84
11		1		01	43	x→M	4	55	04
12		=		84	44	RM	2	65	02
13	F	$1/x$	F	43	45	F	x^2	F	44
14	x→M	2	55	02	46		x		54
15	RM	1	65	01	47		·		83
16	F	x^2	F	44	48		3		03
17		÷		44	49		5		05
18		2		02	50		6		06
19		+/–		82	51		5		05
20		=		84	52		6		06
21		e^x		32	53		3		03
22		÷		44	54		7		07
23		(		42	55		8		08
24		2		02	56		2		02
25		x		54	57		+/–		82
26	F	π	F	41	58		=		84
27		)		43	59	M+	4	75	04
28	F	$\sqrt{}$	F	42	60		‡		45
29		=		84	61		x		54
30	x→M	3	55	03	62	RM	2	65	02
31	RM	2	65	02	63		x		54

	MEMORY			LABEL		
4		4	$\sqrt{}$	s		4
5		5		t		5
6	$\phi(x)$	6		0		6
7	x	7		1		7
8	$\sqrt{}$	8		2		8
9	$\sqrt{}$	9		3		9

STEP	KEY	KEY CODE	STEP	KEY	KEY CODE
64	1	01	96	RM	2	65	02
65	·	83	97		×		54
66	7	07	98		1		01
67	8	08	99		·		83
68	1	01	100		3		03
69	4	04	101		3		03
70	7	07	102		0		00
71	9	09	103		2		02
72	3	03	104		7		07
73	7	07	105		4		04
74	=	84	106		4		04
75	M+ 4	75 04	107		2		02
76	↕	45	108		9		09
77	×	54	109		+		74
78	RM 2	65 02	110	RM	4	65	04
79	×	54	111		×		54
80	1	01	112	RM	3	65	03
81	·	83	113		+/−		82
82	8	08	114		+		74
83	2	02	115		1		01
84	1	01	116		=		84
85	2	02	117	x→M	0	55	00
86	5	05	118		S/E		85
87	5	05	119				
88	9	09	120				
89	7	07	121				
90	8	08	122				
91	+/−	82	123				
92	=	84	124				
93	M+ 4	75 04	125				
94	↕	45	126				
95	×	54	127				

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE PERCENTAILE OF NORMAL DISTRIBUTION

PROGRAM NO. P2–B–3

[Formula]

If the normal distribution function is given as follows;

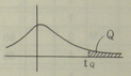
$$Q=\int_{t_Q}^{\infty}\phi(t)\,dt=\int_{t_Q}^{\infty}\frac{1}{\sqrt{2\pi}}e^{-\frac{t^2}{2}}dt=1-\phi(t_Q)$$

$$\phi(t_Q)=\int_{-\infty}^{t_Q}\phi(t)\,dt$$

the percentaile of nomal distribution function is represented by t_Q. It is determined with the aid of Hastings' best approximate equation.

$$x=\sqrt{\ln Q^{-2}}$$

$$t_Q\fallingdotseq x-\frac{c_0+c_1x+c_2x^2}{1+d_1x+d_2x^2+d_3x^3}$$



$c_0=2.515517$ $d_1=1.432788$

$c_1=0.802853$ $d_2=0.189269$

$c_2=0.01032$ $d_3=0.001308$

[Example]

$Q=0.02,\ 0.05$

[Operation]

CA

(Q) 0.02 S/E (t_Q) 2.054198193

(Q) 0.05 S/E (t_Q) 1.645219908

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	1	55	01	32		7		07
1	F	x^2	F	44	33		8		08
2	F	1/x	F	43	34		8		08
3		ln		33	35		=		84
4	F	√	F	42	36	x→M	3	55	03
5	x→M	4	55	04	37	RM	4	65	04
6		2		02	38	F	x^2	F	44
7		·		83	39		x		54
8		5		05	40		·		83
9		1		01	41		0		00
10		5		05	42		1		01
11		5		05	43		0		00
12		1		01	44		3		03
13		7		07	45		2		02
14	x→M	2	55	02	46		=		84
15	RM	4	65	04	47	M+	2	75	02
16		x		54	48		‡		45
17		·		83	49		x		54
18		8		08	50		·		83
19		0		00	51		1		01
20		2		02	52		8		08
21		8		08	53		9		09
22		5		05	54		2		02
23		3		03	55		6		06
24	M+	2	75	02	56		9		09
25	RM	4	65	04	57		=		84
26		x		54	58	M+	3	75	03
27		1		01	59		‡		45
28		·		83	60		x		54
29		4		04	61	RM	4	65	04
30		3		03	62		x		54
31		2		02	63		·		83

MEMORY

s		4	√
t		5	
0	r_0	6	
1	ϱ	7	
2	√	8	
3	√	9	

LABEL

s		4	
t		5	
0		6	
1		7	
2		8	
3		9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64		0		00	96				
65		0		00	97				
66		1		01	98				
67		3		03	99				
68		0		00	100				
69		8		08	101				
70	M+	3	75	03	102				
71		1		01	103				
72	M+	3	75	03	104				
73	RM	2	65	02	105				
74		÷		44	106				
75	RM	3	65	03	107				
76		+/–		82	108				
77		+		74	109				
78	RM	4	65	04	110				
79		=		84	111				
80	x→M	0	55	00	112				
81		S/E		85	113				
82					114				
83					115				
84					116				
85					117				
86					118				
87					119				
88					120				
89					121				
90					122				
91					123				
92					124				
93					125				
94					126				
95					127				

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE UPPER & LOWER CONFIDENCE LIMIT OF POPULATION MEAN

PROGRAM NO. P2-B-4

[Formula]

From the samples (size = n), this program calculates upper and lower confidence limit of population mean.

where $P(-t_\alpha < \frac{\bar{X}-\mu}{\sqrt{V/n}} < t_\alpha) =$ confidence coefficient

Confidence limits is $\bar{X} \pm \sqrt{V/n}\, t_\alpha$

where $\phi = n - 1$

[Example]

12.3 12.4 12.1 12.4 12.2

$\alpha = 0.95$

[Operation]

If $\bar{x}$, s . . . known,

CA

(n) S/E

($\bar{x}$) S/E

(s) S/E (ϕ)

(t_α) S/E (lower limit)

S/E (upper limit)

If $\bar{x}$, s . . . unknown,

GTO 0 S/E

(x_1) 12.3 $n\Sigma$

(x_2) 12.4 $n\Sigma$

. . .

(x_n) 12.2 $n\Sigma$

S/E (ϕ) 4

(t_α) 2.78 S/E (lower limit) 12.11789953

S/E (upper limit) 12.44210046

Note;

$n = 5$

$\bar{x} = 12.28$

$s = 1.303840481 \times 10^{-1}$

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
0		x→M	1	55	01	32			x		54
1		F	HLT	F	12	33		RM	t	65	83
2		x→M	3	55	03	34		M+	9	75	09
3		F	HLT	F	12	35			+/–		82
4		x→M	5	55	05	36		M+	8	75	08
5		GTO	t	14	83	37		RM	8	65	08
6	F	LBL	0	F 13	00	38		F	HLT	F	12
7			C·CE		35	39		RM	9	65	09
8			C·CE		35	40			S/E		85
9		F	HLT	F	12	41					
10		x→M	1	55	01	42					
11		F	$\bar{x}$'s	F	34	43					
12		x→M	3	55	03	44					
13			‡		45	45					
14		x→M	5	55	05	46					
15	F	LBL	t	F 13	83	47					
16			÷		44	48					
17		RM	1	65	01	49					
18		F	$\sqrt{}$	F	42	50					
19			=		84	51					
20		x→M	2	55	02	52					
21		RM	1	65	01	53					
22			–		64	54					
23			1		01	55					
24			=		84	56					
25		x→M	7	55	07	57					
26		F	HLT	F	12	58					
27		x→M	t	55	83	59					
28		RM	3	65	03	60					
29		x→M	8	55	08	61					
30		x→M	9	55	09	62					
31		RM	2	65	02	63					

MEMORY					LABEL			
s		4			s		4	
t	t_α	5	s		t	√	5	
0		6			0	√	6	
1	n_1	7	ϕ		1		7	
2	working	8	min		2		8	
3	$\bar{x}$	9	max		3		9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **UPPER & LOWER CONFIDENCE LIMIT OF POPULATION VARIANCE**

PROGRAM NO. P2-8-5

[Formula]

From the samples (size = n), this program calculates upper and lower confidence limit of population variance.

Where $P(\chi_1^2 < S_{xx}/\sigma^2 < \chi_2^2) =$ confidence coefficient.

Confidence limits is $\frac{S_{xx}}{\chi_2^2}$ $\frac{S_{xx}}{\chi_1^2}$

where $\phi = n - 1$

[Example]

28.0 27.7 27.0 27.7 25.7 27.7

28.3 27.8 26.4 26.5 27.1

$\alpha = 0.98$

[Operation]

If s . . . known,	If s . . . unknown
CA	GTO 0 S/E
(n) S/E	(x_1) 28.0 n!Σ
(s) S/E (ϕ)	(x_2) 27.7 n!Σ
(χ_1^2) S/E	(x_3) 27.0 n!Σ
(χ_2^2) S/E (lower limit)	⋮ ⋮ ⋮
S/E (upper limit)	(x_n) 27.1 n!Σ
	S/E (ϕ) 10
	(χ_1^2) 2.558 S/E
	(χ_2^2) 23.209 S/E (lower limit) $2.734049722 \times 10^{-1}$
	S/E (upper limit) 2.480631744

Note:

n = 11, s = $7.965837056 \times 10^{-1}$

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	1	55	01	32		=		84
1	F	HLT	F	12	33	x→M	8	55	08
2	x→M	5	55	05	34	F	HLT	F	12
3	GTO	t	14	83	35	RM	2	65	02
4	F LBL	0	F 13	00	36		÷		44
5		C·CE		35	37	RM	s	65	82
6		C·CE		35	38		=		84
7	F	HLT	F	12	39	x→M	9	55	09
8	x→M	1	55	01	40		S/E		85
9	F	$\bar{x}$s	F	34	41				
10		‡		45	42				
11	x→M	5	55	05	43				
12	F LBL	t	F 13	83	44				
13	RM	1	65	01	45				
14		–		64	46				
15		1		01	47				
16		=		84	48				
17	x→M	7	55	07	49				
18		x		54	50				
19	RM	5	65	05	51				
20	F	x^2	F	44	52				
21	x→M	6	55	06	53				
22		=		84	54				
23	x→M	2	55	02	55				
24	RM	7	65	07	56				
25	F	HLT	F	12	57				
26	x→M	s	55	82	58				
27	F	HLT	F	12	59				
28	x→M	t	55	83	60				
29	RM	2	65	02	61				
30		÷		44	62				
31	RM	t	65	83	63				

MEMORY					LABEL		
a	x_1^2	4		s		4	
1	x_1^3	5	s	t	√	5	
0		6	V	0	√	6	
1	n	7	ϕ	1		7	
2		8	min	2		8	
3		9	max	3		9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE: t – TEST OF $\bar{x} = \mu$

PROGRAM NO.: P2–B–6

[Formula]

This program calculates t–test. (null hypothesis . . . $x \neq \mu$)

$$t = \frac{\bar{x} - \mu}{s / \sqrt{n}} \quad \text{where } \phi = n - 1$$

[Example]

1790 1780 1800 1800 1800

1810 1790 1780 1810 1790

where null hypothesis is $\mu \neq 1800$

[Operation]

If $\bar{x}$, s . . . known

CA

(μ) S/E

(n) S/E

($\bar{x}$) S/E

(s) S/E (t)

S/E (ϕ)

If $\bar{x}$, s . . . unknown

GTO 0

(μ) 1800 S/E

(x_1) 1790 n Σ

(x_2) 1780 n Σ

(x_3) 1800 n Σ

⋮

(x_n) 1790 n Σ

S/E (t) −1.463850109

S/E (ϕ) 9

Note:

n = 10

$\bar{x}$ = 1795

s = 10.8012345

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	0	55	00	32		)		43
1	F	HLT	F	12	33		=		84
2	x→M	1	55	01	34	x→M	t	55	83
3	F	HLT	F	12	35	F	HLT	F	12
4	x→M	3	55	03	36	RM	7	65	07
5	F	HLT	F	12	37		S/E		85
6	x→M	5	55	05	38				
7	GTO	t	14	83	39				
8	F LBL	0	F 13	00	40				
9	x→M	0	55	00	41				
10		C·CE		35	42				
11		C·CE		35	43				
12	F	HLT	F	12	44				
13	x→M	1	55	01	45				
14	F	$\bar{x}$ s	F	34	46				
15	x→M	3	55	03	47				
16		‡		45	48				
17	x→M	5	55	05	49				
18	F LBL	t	F 13	83	50				
19		1		01	51				
20		+/−		82	52				
21	x→M	7	55	07	53				
22	RM	1	65	01	54				
23	M+	7	75	07	55				
24	F	√	F	42	56				
25		÷		44	57				
26	RM	5	65	05	58				
27		×		54	59				
28		(		42	60				
29	RM	3	65	03	61				
30		−		64	62				
31	RM	0	65	00	63				

MEMORY

s		4			
1	t	5	s		
0	μ	6			
1	n	7	φ		
2		8			
3	$\bar{x}$	9			

LABEL

s		4	
t	√	5	
0	√	6	
1		7	
2		8	
3		9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE: χ^2 – TEST OF $S^2 = \sigma^2$

PROGRAM NO.: P2–B–7

[Formula]

This program calculates χ^2–test. (null hypothesis . . . $s^2 \neq \sigma^2$)

$$\chi^2 = \frac{S_{xx}}{\sigma^2} \quad \text{where } \phi = n - 1$$

[Example]

0.41 0.39 0.44 0.64 0.42 0.59

0.49 0.44 0.64 0.42 0.60 0.38

where null hypothesis is $\sigma^2 \neq 0.04$

[Operation]

If s . . . known	If s . . . unknown
CA	GTO 0
(σ^2) S/E	(σ^2) 0.04 S/E
(n) S/E	(x_1) 0.41 $n\Sigma$
(s) S/E (χ^2)	(x_2) 0.39 $n\Sigma$
S/E (ϕ)	⋮ ⋮ ⋮
	(x_n) 0.38 $n\Sigma$
	S/E (χ^2) 2.759166673
	S/E (ϕ) 11

Note: n = 12, s = $1.001665281 \times 10^{-1}$

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	0	55	00	32				
1	F	HLT	F	12	33				
2	x→M	1	55	01	34				
3	F	HLT	F	12	35				
4	x→M	5	55	05	36				
5	GTO	t	14	83	37				
6	F LBL	0	F 13	00	38				
7	x→M	0	55	00	39				
8		C·CE		35	40				
9		C·CE		35	41				
10	F	HLT	F	12	42				
11	x→M	1	55	01	43				
12	F	$\bar{x}$s	F	34	44				
13		↕		45	45				
14	x→M	5	55	05	46				
15	F LBL	t	F 13	83	47				
16	RM	1	65	01	48				
17		–		64	49				
18		1		01	50				
19		=		84	51				
20	x→M	7	55	07	52				
21		x		54	53				
22	RM	5	65	05	54				
23	F	x^2	F	44	55				
24		÷		44	56				
25	RM	0	65	00	57				
26		=		84	58				
27	x→M	t	55	83	59				
28	F	HLT	F	12	60				
29	RM	7	65	07	61				
30		S/E		85	62				
31					63				

MEMORY				LABEL			
s	σ^2	4		s		4	
t	χ^2	5	s	t	√	5	
0	n	6		0	√	6	
1		7	ϕ	1		7	
2		8		2		8	
3		9		3		9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2-B-8

TITLE **TEST OF DIFFERENCE IN MEANS**

[Formula]

$$t=\frac{\bar{x}_1-\bar{x}_2}{S_{x\sigma 1}+S_{x\sigma 2}}\sqrt{\frac{n_1 n_2\,(n_1+n_2-2)}{n_1+n_2}}$$

[Example]

1	2.3	1.6	2.1	2.2	2.3	2.0	1.9	2.2
2	2.3	2.5	2.0	2.1	2.2	2.1		

[Operation]

If $\bar{x}$, s . . . known

CA

(n_1) S/E

($\bar{x}_1$) S/E

(s_1) S/E

(n_2) S/E

($\bar{x}_2$) S/E

(s_2) S/E (t)

S/E (φ)

If $\bar{x}$, s . . . unknown

GTO 0 S/E

(x_{11}) 2.3 n Σ

(x_{12}) 1.6 n Σ

⋮

(x_{1n_1}) 2.2 n Σ

S/E

(x_{21}) 2.3 n Σ

(x_{22}) 2.5 n Σ

⋮

(x_{2n_2}) 2.1 n Σ

S/E (t) −1.076244005

S/E (φ) 12

Note: $n_1=8$, $\bar{x}_1=2.075$ $s_1=2.375469878\times10^{-1}$

$n_2=6$, $\bar{x}_2=2.2$ $s_2=1.788854382\times10^{-1}$

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	1	55	01	32	RM	2	65	02
1	F	HLT	F	12	33		–		64
2	x→M	3	55	03	34		2		02
3	F	HLT	F	12	35		=		84
4	x→M	5	55	05	36	x→M	7	55	07
5	F	HLT	F	12	37		×		54
6	x→M	2	55	02	38	RM	1	65	01
7	F	HLT	F	12	39		×		54
8	x→M	4	55	04	40	RM	2	65	02
9	F	HLT	F	12	41		÷		44
10	x→M	6	55	06	42		(		42
11	GTO	t	14	83	43	RM	1	65	01
12	F LBL	0	F 13	00	44		–		64
13		C·CE		35	45		1		01
14		C·CE		35	46		×		54
15	F	HLT	F	12	47	RM	5	65	05
16	x→M	1	55	01	48	F	x^3	F	44
17	F	$\bar{x}$s	F	34	49		+		74
18	x→M	3	55	03	50		(		42
19		↕		45	51	RM	2	65	02
20	x→M	5	55	05	52		–		64
21		C·CE		35	53		1		01
22		C·CE		35	54		×		54
23	F	HLT	F	12	55	RM	6	65	06
24	x→M	2	55	02	56	F	x^2	F	44
25	F	$\bar{x}$s	F	34	57		)		43
26	x→M	4	55	04	58		×		54
27		↕		45	59		(		42
28	x→M	6	55	06	60	RM	1	65	01
29	F LBL	t	F 13	83	61		+		74
30	RM	1	65	01	62	RM	2	65	02
31		+		74	63		)		43

MEMORY			
0		4	$\bar{x}_2$
1	t	5	s_1
2	n_1	6	s_2
3	n_2	7	φ
4	$\bar{x}_1$	8	
		9	

LABEL			
s		4	
t	√	5	
0	√	6	
1		7	
2		8	
3		9	

STEP	KEY		KEY CODE		STEP	KEY	KEY CODE
64		)		43	96		
65		=		84	97		
66	F	√	F	42	98		
67		x		54	99		
68		(		42	100		
69	RM	3	65	03	101		
70		−		64	102		
71	RM	4	65	04	103		
72		)		43	104		
73		=		84	105		
74	x→M	t	55	83	106		
75	F	HLT	F	12	107		
76	RM	7	65	07	108		
77		S/E		85	109		
78					110		
79					111		
80					112		
81					113		
82					114		
83					115		
84					116		
85					117		
86					118		
87					119		
88					120		
89					121		
90					122		
91					123		
92					124		
93					125		
94					126		
95					127		

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **F – TEST**

PROGRAM NO. P2–B–9

[Formula]

This program calculates F– test

$F = V_1 / V_2$, where $\phi_1 = n_1 - 1$

$\phi_2 = n_2 - 1$

If $V_1 < V_2$, exchanged 1 for 2.

[Example]

1	1.375	1.407	1.068	1.752	1.201
	1.042	1.223	1.633	1.773	0.779
2	1.033	1.217	1.615	0.673	
	1.252	0.984	1.693	0.840	

[Operation]

○ If s is known

CA

(n_1) S/E

(s_1) S/E

(n_2) S/E

(s_2) S/E (F)

S/E (ϕ_1)

S/E (ϕ_2)

○ If s is unknown

GTO 0 S/E

(x_{11}) 1.375 n Σ

(x_{12}) 1.407 n Σ

⋮ ⋮

(x_{1n_1}) 0.779 n Σ

S/E

(x_{21}) 1.033 n Σ

(x_{22}) 1.217 n Σ

⋮ ⋮

(x_{2n_2}) 0.840 n Σ

S/E (F) 1.194715643

S/E (ϕ_1) 7

S/E (ϕ_2) 9

Note: $n_1 = 10$, $s_1 = 3.261141757 \times 10^{-1}$

$n_2 = 8$, $s_2 = 3.564527359 \times 10^{-1}$

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	1	55	01	32	RM	5	65	05
1	F	HLT	F	12	33	÷			44
2	x→M	5	55	05	34	RM	6	65	06
3	F	HLT	F	12	35	=			84
4	x→M	2	55	02	36	F	x^3	F	44
5	F	HLT	F	12	37	x→M	t	55	83
6	x→M	6	55	06	38	1			01
7	GTO	t	14	83	39	F $x<t$	1	F 85	01
8	F LBL	0	F 13	00	40	RM	t	65	83
9	C·CE			35	41	F	1/x	F	43
10	C·CE			35	42	x→M	t	55	83
11	F	HLT	F	12	43	RM	7	65	07
12	x→M	1	55	01	44	x→M	s	55	82
13	F	$\bar{x}$s	F	34	45	RM	8	65	08
14		↕		45	46	x→M	7	55	07
15	x→M	5	55	05	47	RM	s	65	82
16	C·CE			35	48	x→M	8	55	08
17	C·CE			35	49	F LBL	1	F 13	01
18	F	HLT	F	12	50	RM	t	65	83
19	x→M	2	55	02	51	F	HLT	F	12
20	F	$\bar{x}$s	F	34	52	RM	7	65	07
21		↕		45	53	F	HLT	F	12
22	x→M	6	55	06	54	RM	8	65	08
23	F LBL	1	F 13	83	55		S/E		85
24	RM	1	65	01	56				
25	x→M	7	55	07	57				
26	RM	2	65	02	58				
27	x→M	8	55	08	59				
28		1		01	60				
29		+/−		82	61				
30	M+	7	75	07	62				
31	M+	8	75	08	63				

MEMORY

s	working	4	
t	F	5	s_1
0		6	s_2
1	n_1	7	ϕ_1
2	n_2	8	ϕ_2
3		9	

LABEL

s		4	
t	√	5	
0	√	6	
1	√	7	
2		8	
3		9	

SHARP

ANGLE DESIGNATION: DEG RAD GRAD

TITLE GOODNESS OF FIT TEST

PROGRAM NO. P2–B–10

[Formula]

This program calculates the value of the χ^2 statistic for the goodness of fit test by the equation.

$$\chi^2=\sum\frac{(n_i-m_i)^2}{m_i}$$

where n_i .... observed frequency.
m_i .... expected frequency.
$\phi = k - 1$

[Example]

observed	16	8	12	11	14	9
expected	10	10	10	10	10	10

[Operation]

CA

(n_1) 16 S/E

(m_1) 10 S/E

(n_2) 8 S/E

(m_2) 10 S/E

⋮ ⋮ ⋮

(n_k) 9 S/E

(m_k) 10 S/E

GTO 0 S/E (χ^2) 6.2

S/E (ϕ) 5

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
0		F	CAM	F	45	32					
1	F	LBL	1	F	13	01	33				
2		x↔M	1		55	01	34				
3		F	HLT		F	12	35				
4		x↔M	2		55	02	36				
5		RM	1		65	01	37				
6			−			64	38				
7		RM	2		65	02	39				
8			=			84	40				
9		F	x^3		F	44	41				
10			÷			44	42				
11		RM	2		65	02	43				
12		M+	3		75	03	44				
13			1			01	45				
14		M+	0		75	00	46				
15		F	HLT		F	12	47				
16		GTO	1		14	01	48				
17	F	LBL	0	F	13	00	49				
18			1			01	50				
19			+/−			82	51				
20		M+	0		75	00	52				
21		RM	3		65	03	53				
22		F	HLT		F	12	54				
23		RM	0		65	00	55				
24			S/E			85	56				
25							57				
26							58				
27							59				
28							60				
29							61				
30							62				
31							63				

MEMORY			LABEL		
s		4	s		4
t		5	t		5
0	ϕ	6	0	√	6
1	n_i	7	1	√	7
2	m_i	8	2		8
3	Σ	9	3		9

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **2 X 2 CONTINGENCY**

PROGRAM NO. P2–B–11

[Formula]

From 2 x 2 contingency, this program calculates χ_0^2 and χ_1^2 with yates' rule.

$$\chi_0^2 = \frac{(ad-bc)^2 n}{efgh}$$

$$\chi_1^2 = \frac{(ad-bc \pm n/2)^2 n}{efgh}$$

※where ± is defined as ( )² is small.

[Example]

	B_1	B_2
A_1	286	178
A_2	64	22

[Operation]

CA

(a) 286 S/E

(b) 178 S/E

(c) 64 S/E

(d) 22 S/E (χ_0^2) 5.121398499

(χ_1^2) 4.583981466

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	0	55	00	32		(		42
1	x→M	4	55	04	33	RM	1	65	01
2	x→M	6	55	06	34		x		54
3	x→M	8	55	08	35	RM	2	65	02
4	F	HLT	F	12	36		)		43
5	x→M	1	55	01	37		=		84
6	x→M	5	55	05	38	F	abs	F	82
7	M+	6	75	06	39	x→M	s	55	82
8	M+	8	75	08	40	F GTS	0	F 14	00
9	F	HLT	F	12	41	x→M	t	55	83
10	x→M	2	55	02	42	F	HLT	F	12
11	M+	4	75	04	43	RM	8	65	08
12	x→M	7	55	07	44		÷		44
13	M+	8	75	08	45		2		02
14	F	HLT	F	12	46		+/–		82
15	x→M	3	55	03	47	M+	s	75	82
16	M+	5	75	05	48	F GTS	0	F 14	00
17	M+	7	75	07	49	x→M	s	55	82
18	M+	8	75	08	50		S/E		85
19	RM	4	65	04	51	F LBL	0	F 13	00
20		x		54	52	RM	s	65	82
21	RM	5	65	05	53	F	x^2	F	44
22		x		54	54		x		54
23	RM	6	65	06	55	RM	8	65	08
24		x		54	56		÷		44
25	RM	7	65	07	57	RM	9	65	09
26		=		84	58		=		84
27	x→M	9	55	09	59		S/E		85
28	RM	0	65	00	60				
29		x		54	61				
30	RM	3	65	03	62				
31		–		64	63				

MEMORY

s	x^2_s	4	e
t	x^2_t	5	f
0	a	6	g
1	b	7	h
2	c	8	n
3	d	9	efgh

LABEL

s		4	
t		5	
0	Sub	6	
1		7	
2		8	
3		9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **MOVING AVERAGE (3 OR 4 TERMS)**

PROGRAM NO. P2–B–12

[Formula]

○ 3 terms

$\bar{x}_3 = (x_1 + x_2 + x_3)/3$

$\bar{x}_i = (x_{i-2} + x_{i-1} + x_i)/3$

○ 4 terms

$\bar{x}_i = (x_{i-3} + x_{i-2} + x_{i-1} + x_i)/4$

[Example]

○ 3 terms···42, 74, 15, 49, 34, 88, 41, 45, ·····

○ 4 terms···56, 79, 0, 97, 20, 53, 99, 68, ·····

[Operation]

○ 3 terms

GTO 3
(x_1) 42 S/E
(x_2) 74 S/E
(x_3) 15 S/E 43.66666667
(x_4) 49 S/E 46
(x_5) 34 S/E 32.66666667
(x_6) 88 S/E 57
(x_7) 41 S/E 54.33333333
(x_8) 45 S/E 58
⋮ ⋮ ⋮ ⋮

○ 4 terms

GTO 4
(x_1) 56 S/E
(x_2) 79 S/E
(x_3) 0 S/E
(x_4) 97 S/E 58
(x_5) 20 S/E 49
(x_6) 53 S/E 42.5
(x_7) 99 S/E 67.25
(x_8) 68 S/E 60
⋮ ⋮ ⋮ ⋮

STEP	KEY			KEY CODE		
0	F	LBL	0	F	13	00
1		x→M	3		55	03
2		F	HLT		F	12
3		x→M	2		55	02
4		F	HLT		F	12
5		x→M	1		55	01
6			S/E			85
7	F	LBL	1	F	13	01
8		RM	1		65	01
9			+			74
10		RM	2		65	02
11			+			74
12		RM	3		65	03
13			S/E			85
14	F	LBL	t	F	13	83
15		RM	2		65	02
16		x→M	3		55	03
17		RM	1		65	01
18		x→M	2		55	02
19		RM	0		65	00
20		F	HLT		F	12
21		x→M	1		55	01
22			S/E			85
23	F	LBL	3	F	13	03
24	F	GTS	0	F	14	00
25	F	LBL	s	F	13	82
26	F	GTS	1	F	14	01
27			÷			44
28			3			03
29			=			84
30		x→M	0		55	00
31	F	GTS	t	F	14	83

STEP	KEY			KEY CODE		
32		GTO	s		14	82
33	F	LBL	4	F	13	04
34		x→M	4		55	04
35		F	HLT		F	12
36	F	GTS	0	F	14	00
37	F	LBL	5	F	13	05
38	F	GTS	1	F	14	01
39			+			74
40		RM	4		65	04
41			÷			44
42			4			04
43			=			84
44		x→M	0		55	00
45		RM	3		65	03
46		x→M	4		55	04
47	F	GTS	t	F	14	83
48		GTO	5		14	05
49						
50						
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						

MEMORY

s		4	x_4
t		5	
0	$\bar{x}$	6	
1	x_1	7	
2	x_2	8	
3	x_3	9	

LABEL

s	√	4	√
t	√	5	√
0	√	6	
1	√	7	
2		8	
3	√	9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE COVARIANCE, CORRELATION AND LINEAR REGRESSION

PROGRAM NO. P2–B–13

[Formula]

This program calculates covariance, coefficient of correlation and coefficient of linear regression between two variables.

$S_{xx}=\sum x_i^2-n\bar{x}$

$S_{xy}=\sum x_i y_i-n\bar{x}\ \bar{y}$

$S_{yy}=\sum y_i^2-n\bar{y}$

$C = S_{xy}/n$ ··· covariance

$r = S_{xy}/\sqrt{S_{xx}\,S_{yy}}$ ··· coefficient of correlation

$a = S_{xy}/S_{xx}$

$b = \bar{y}-a\bar{x}$

} coefficient of regression ($y=ax+b$)

[Example]

x	6.9	7.6	7.6	9.0	8.1	6.5	6.4	6.9
y	12	10	9	5	6	15	14	12

[Operation]

CA

(x_1) 6.9 S/E

(y_1) 12 S/E

(x_2) 7.6 S/E

(y_2) 10 S/E

⋮ ⋮ ⋮

(x_n) 6.9 S/E

(y_n) 12 S/E

Continued if calculates y,

(x) 6.4 S/E (y) 14.21849126

(x) 6.9 S/E (y) 12.24747011

(x) 8.1 S/E (y) 7.51701932

⋮ ⋮ ⋮ ⋮

GTO 0 S/E (c) −2.678125

S/E (r) −9.693968513×10⁻¹

S/E (a) −3.942042318

S/E (b) 39.4475621

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0		F	CAM		F	45	32	M+	4		75	04	
1	F	LBL	1	F	13	01	33	RM	4		65	04	
2		x→M	6		55	06	34		÷			44	
3		M+	1		75	01	35	RM	0		65	00	
4		F	x^2		F	44	36	M+	8		75	08	
5		M+	3		75	03	37	F	HLT		F	12	
6		F	HLT		F	12	38	RM	4		65	04	
7		x→M	7		55	07	39		÷			44	
8		M+	2		75	02	40		(			42	
9		F	x^2		F	44	41	RM	3		65	03	
10		M+	5		75	05	42		x			54	
11		RM	6		65	06	43	RM	5		65	05	
12			x			54	44		)			43	
13		RM	7		65	07	45	F	$\sqrt{}$		F	42	
14		M+	4		75	04	46	M+	9		75	09	
15			1			01	47	F	HLT		F	12	
16		M+	0		75	00	48	RM	4		65	04	
17		F	HLT		F	12	49		÷			44	
18		GTO	1		14	01	50	RM	3		65	03	
19	F	LBL	0	F	13	00	51	M+	s		75	82	
20		RM	1		65	01	52	F	HLT		F	12	
21		F	x^2		F	44	53	RM	2		65	02	
22	F	GTS	2	F	14	02	54		−			64	
23		M+	3		75	03	55		(			42	
24		RM	2		65	02	56	RM	1		65	01	
25		F	x^2		F	44	57		x			54	
26	F	GTS	2	F	14	02	58	RM	s		65	82	
27		M+	5		75	05	59		)			43	
28		RM	1		65	01	60		÷			44	
29			x			54	61	RM	0		65	00	
30		RM	2		65	02	62	M+	t		75	83	
31	F	GTS	2	F	14	02	63	GTO	t		14	83	

MEMORY

s	a	4	$\Sigma x_i y_i$, S_{xy}
t	b	5	Σy_i^2, S_{yy}
0	n	6	x
1	Σx_i	7	y
2	Σy_i	8	C
3	Σx_i^2, S_{xx}	9	r

LABEL

s		4	
t	$\sqrt{}$	5	
0	$\sqrt{}$	6	
1	$\sqrt{}$	7	
2	Sub	8	
3		9	

STEP	KEY			KEY CODE			STEP	KEY	KEY CODE
64	F	LBL	t	F	13	83	96		
65		F	HLT		F	12	97		
66		x→M	6		55	06	98		
67			x			54	99		
68		RM	s		65	82	100		
69			+			74	101		
70		RM	t		65	83	102		
71			=			84	103		
72		x→M	7		55	07	104		
73		GTO	t		14	83	105		
74	F	LBL	2	F	13	02	106		
75			÷			44	107		
76		RM	0		65	00	108		
77			+/−			82	109		
78			S/E			85	110		
79							111		
80							112		
81							113		
82							114		
83							115		
84							116		
85							117		
86							118		
87							119		
88							120		
89							121		
90							122		
91							123		
92							124		
93							125		
94							126		
95							127		

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **QUADRATIC REGRESSION**

PROGRAM NO.
P2-B-14

[Formula]

This program computes a, b, c, in $y=ax^2+bx+c$ to a set of points and estimates y for a given x.

$$S_{xx}=\sum x_i^2-n\,\bar{x}^2$$

$$S_{xy}=\sum x_i y_i-n\,\bar{x}\,\bar{y}$$

$$S_{xx^2}=\sum x_i^3-n\,\bar{x}\,\bar{x^2}$$

$$S_{x^2y}=\sum x_i^2 y_i-n\,\bar{x^2}\,\bar{y}$$

$$S_{x^2x^2}=\sum x_i^4-n\,\bar{x^2}^2$$

therefore

$$\det=S_{xx}S_{x^2x^2}-S_{xx^2}^2$$

$$a=(S_{x^2y}S_{xx}-S_{xy}S_{xx^2})/\det$$

$$b=(S_{xy}S_{x^2x^2}-S_{x^2y}S_{xx^2})/\det$$

$$c=\bar{y}-b\,\bar{x}-a\bar{x^2}$$

[Example]

x	1	3	5	7	9	11	13	15
y	38	38	56	62	70	65	81	87

Compute a curve ($y = ax^2 + bx + c$) fitting the above data, and estimate y when x = 17, 19.

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **QUADRATIC REGRESSION**

PROGRAM NO.
P2-B-14

[Operation]

	CA	
(x_1)	1 S/E	
(y_1)	38 S/E	
(x_2)	3 S/E	
(y_2)	38 S/E	
⋮	⋮	
(x_n)	15 S/E	
(y_n)	87 S/E	
	GTO 0 S/E	(a) -4.31547619×10^{-2}
	S/E	(b) 4.220238095
	S/E	(c) 32.03125
(estimation x)	17 S/E	(y) 91.30357143
(estimation x)	19 S/E	(y) 96.63690476
⋮	⋮	⋮ ⋮

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		F	CAM		F	45	32			=				84
1	F	LBL	1	F	13	01	33		x→M	4		55	04	
2		x→M	9		55	09	34		RM	1		65	01	
3		M+	1		75	01	35			x			54	
4		F	x^2		F	44	36		RM	3		65	03	
5		M+	3		75	03	37			÷			44	
6		F	x^2		F	44	38		RM	0		65	00	
7		M+	6		75	06	39			+/–			82	
8			÷			44	40		M+	5		75	05	
9		RM	9		65	09	41		RM	3		65	03	
10		M+	5		75	05	42		F	x^2		F	44	
11		F	HLT		F	12	43			÷			44	
12		M+	2		75	02	44		RM	0		65	00	
13			x			54	45			+/–			82	
14		RM	9		65	09	46		M+	6		75	06	
15		M+	7		75	07	47		RM	2		65	02	
16			x			54	48			÷			44	
17		RM	9		65	09	49		RM	0		65	00	
18		M+	8		75	08	50			+/–			82	
19			1			01	51			x			54	
20		M+	0		75	00	52		RM	1		65	01	
21		F	HLT		F	12	53			=			84	
22		GTO	1		14	01	54		M+	7		75	07	
23	F	LBL	0	F	13	00	55		RM	3		65	03	
24		RM	3		65	03	56			=			84	
25			–			64	57		M+	8		75	08	
26			(			42	58		RM	4		65	04	
27		RM	1		65	01	59			x			54	
28		F	x^2		F	44	60		RM	6		65	06	
29			÷			44	61			–			64	
30		RM	0		65	00	62		RM	5		65	05	
31			)			43	63		F	x^2		F	44	

MEMORY

s	a	4	S_{xx}
t	b	5	Σx_i^3, S_{xx^2}
0	n, $\hat{x}$	6	Σx_i^4, $S_{x^2x^2}$
1	Σx_i, $\hat{y}$	7	$\Sigma x_i y_i$, S_{xy}
2	Σy_i	8	$\Sigma x_i^2 y_i$, S_{x^2y}
3	Σx_i^2	9	$\bar{x}$, det, C

LABEL

s		4	
t	√	5	
0	√	6	
1	√	7	
2		8	
3		9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64		=		84	96		x		54					
65	x→M	9	55	09	97	RM	3	65	03					
66	RM	8	65	08	98		)		43					
67		x		54	99		–		64					
68	RM	4	65	04	100		(		42					
69		–		64	101	RM	t	65	83					
70		(		42	102		x		54					
71	RM	7	65	07	103	RM	1	65	01					
72		x		54	104		)		43					
73	RM	5	65	05	105		÷		44					
74		)		43	106	RM	0	65	00					
75		÷		44	107		=		84					
76	RM	9	65	09	108	x→M	9	55	09					
77	M+	s	75	82	109	GTO	t	14	83					
78	F	HLT	F	12	110	F	LBL	t	F	13	83			
79	RM	7	65	07	111		F	HLT		F	12			
80		x		54	112	x→M	0	55	00					
81	RM	6	65	06	113		F	x^2		F	44			
82		–		64	114			x			54			
83		(		42	115	RM	s	65	82					
84	RM	8	65	08	116		+		74					
85		x		54	117		(		42					
86	RM	5	65	05	118	RM	0	65	00					
87		)		43	119		x		54					
88		÷		44	120	RM	t	65	83					
89	RM	9	65	09	121		)		43					
90	M+	t	75	83	122		+		74					
91	F	HLT	F	12	123	RM	9	65	09					
92	RM	2	65	02	124		=		84					
93		–		64	125	x→M	1	55	01					
94		(		42	126	GTO	t	14	83					
95	RM	s	65	82	127									

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **EXPONENTIAL CURVE**

PROGRAM NO. P2-B-15

[Formula]

The coefficients (a, b, and r) are defined as follows,

$$\bar{x}=\sum x_i / n\ ,\quad \bar{Y}=\sum \ln y_i$$

$$S_{xx}=\sum x_i^2-n\bar{x}^2$$

$$S_{xY}=\sum x_i \ln y_i-n\bar{x}\bar{Y}$$

$$S_{YY}=\sum\ (\ln y_i)^2-n\bar{Y}^2$$

$$r=\frac{S_{xY}}{\sqrt{S_{xx}S_{YY}}},\quad b=\frac{S_{xY}}{S_{xx}},\quad a=e^{\bar{Y}-b\bar{x}}$$

[Example]

x	0.5	1.2	3.1	7.4
y	7.01	11.72	44.54	936.71

compute the coeffients and estimate y when $x = 2, 5$

[Operation]

		CA	
(x_1)	0.5	S/E	
(y_1)	7.01	S/E	
(x_2)	1.2	S/E	
(y_2)	11.72	S/E	
⋮	⋮	⋮	
(x_n)	7.4	S/E	
(y_n)	936.71	S/E	
	GTO 0	S/E	(r) 0.999994237
		S/E	(b) 4.96033193
		S/E	(a) 0.708320102
(estimation)2		S/E	(y) 20.45265829
(estimation)5		S/E	(y) 171.2412138
⋮	⋮	⋮	⋮

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	F	CAM	F	45	32	F	GTS	2	F 14 02
1	F	LBL 1	F	13 01	33		M+	4	75 04
2		x→M 6		55 06	34		RM	4	65 04
3		M+ 1		75 01	35			÷	44
4		F x^2		F 44	36			(	42
5		M+ 3		75 03	37		RM	3	65 03
6		F HLT		F 12	38			x	54
7		ln		33	39		RM	5	65 05
8		x→M 7		55 07	40			)	43
9		M+ 2		75 02	41		F	$\sqrt{}$	F 42
10		F x^3		F 44	42		M+	9	75 09
11		M+ 5		75 05	43		F	HLT	F 12
12		RM 6		65 06	44		RM	4	65 04
13		x		54	45			÷	44
14		RM 7		65 07	46		RM	3	65 03
15		M+ 4		75 04	47		M+	t	75 83
16		1		01	48		RM	2	65 02
17		M+ 0		75 00	49			–	64
18		F HLT		F 12	50			(	42
19		GTO 1		14 01	51		RM	t	65 83
20	F	LBL 0	F	13 00	52			x	54
21		RM 1		65 01	53		RM	1	65 01
22		F x^2		F 44	54			)	43
23	F	GTS 2	F	14 02	55			÷	44
24		M+ 3		75 03	56		RM	0	65 00
25		RM 2		65 02	57			=	84
26		F x^3		F 44	58			e^x	32
27	F	GTS 2	F	14 02	59		x→M	s	55 82
28		M+ 5		75 05	60		F	HLT	F 12
29		RM 1		65 01	61		RM	t	65 83
30		x		54	62		GTO	t	14 83
31		RM 2		65 02	63	F	LBL	t	F 13 83

MEMORY

s	a	4	$\Sigma x_i Y_i$, S_{xY}
t	b	5	ΣY_i^2, S_{YY}
0	n	6	x
1	Σx_i	7	Y, y
2	ΣY_i	8	
3	Σx_i^2, S_{xx}	9	r

LABEL

s		4	
t	$\sqrt{}$	5	
0	$\sqrt{}$	6	
1	$\sqrt{}$	7	
2	Sub	8	
3		9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64		F	HLT	F 12	96									
65		x→M	6	55 06	97									
66			x	54	98									
67		RM	t	65 83	99									
68			=	84	100									
69			e^x	32	101									
70			x	54	102									
71		RM	s	65 82	103									
72			=	84	104									
73		x→M	7	55 07	105									
74		GTO	t	14 83	106									
75	F	LBL	2	F 13 02	107									
76			÷	44	108									
77		RM	0	65 00	109									
78			+/−	82	110									
79			S/E	85	111									
80					112									
81					113									
82					114									
83					115									
84					116									
85					117									
86					118									
87					119									
88					120									
89					121									
90					122									
91					123									
92					124									
93					125									
94					126									
95					127									

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **1 – WAY LAYOUT**

PROGRAM NO. P2–8–16

[Formula]

This program calculates analysis of variance by 1-way layout.

level of factor .... A_i $(i = 1 \sim m)$

number of replications .... j $(j = 1 \sim n)$

data .... x_{ij}

$$T_i = \sum_{j=1}^{n} x_{ij}$$

$$CT = (\sum T_i)^2 / mn$$

$$S_T = \sum x_{ij}^2 - CT$$

$$S_A = \sum T_i^2 / n - CT$$

$$S_E = S_T - S_A$$

$$\phi_T = mn - 1$$

$$\phi_A = m - 1$$

$$\phi_E = \phi_T - \phi_A = m(n-1)$$

$$V_A = S_A / \phi_A$$

$$V_E = S_E / \phi_E$$

$$F = V_A / V_E$$

[Example]

Level	x_{ij}				
A_1	−1	2	1	1	−4
A_2	1	2	−4	3	−1
A_3	−3	0	−2	−2	−4
A_4	7	1	2	3	3

SHARP

角度指定
DEG RAD GRAD

TITLE

1－WAY LAYOUT

PROGRAM NO.
P2－B－16

[Operation]

CA

(n) 5 S/E

(m) 4 S/E

(x_{11}) 1 +/− S/E

(x_{12}) 2 S/E

⋮ ⋮ ⋮

(x_{1n}) 4 +/− S/E

(x_{21}) 1 S/E

⋮ ⋮ ⋮

(x_{mn}) 3 S/E (S_A) 74.55

S/E (ϕ_A) 3

S/E (V_A) 24.85

S/E (S_E) 83.2

S/E (ϕ_E) 16

S/E (V_E) 5.2

S/E (S_T) 157.75

S/E (ϕ_T) 19

S/E (F) 4.778846154

STEP	KEY		KEY CODE	STEP	KEY		KEY CODE
0	F	CAM	F 45	32	RM	t	65 83
1	x→M	t	55 83	33		=	84
2	F	HLT	F 12	34	x→M	2	55 02
3	x→M	s	55 82	35		+/−	82
4	F LBL	1	F 13 01	36	M+	3	75 03
5	F	HLT	F 12	37	RM	5	65 05
6	M+	2	75 02	38		÷	44
7	M+	4	75 04	39	RM	t	65 83
8	F	x^2	F 44	40		−	64
9	M+	3	75 03	41	RM	2	65 02
10		1	01	42		=	84
11	M+	1	75 01	43	x→M	5	55 05
12	RM	1	65 01	44	GTO	t	14 83
13	F $x<t$	1	F 85 01	45	F LBL	t	F 13 83
14	RM	4	65 04	46	F	HLT	F 12
15	F	x^2	F 44	47	RM	s	65 82
16	M+	5	75 05	48		x	54
17		1	01	49	RM	t	65 83
18	M+	0	75 00	50		=	84
19		0	00	51	x→M	t	55 83
20	x→M	1	55 01	52		1	01
21	x→M	4	55 04	53		+/−	82
22	RM	s	65 82	54	M+	s	75 82
23		−	64	55	M+	t	75 83
24	RM	0	65 00	56	RM	5	65 05
25		=	84	57		÷	44
26	F $x\neq0$	1	F 55 01	58	RM	s	65 82
27	RM	2	65 02	59	F	HLT	F 12
28	F	x^3	F 44	60		=	84
29		÷	44	61	x→M	0	55 00
30	RM	s	65 82	62	F	HLT	F 12
31		÷	44	63	RM	3	65 03

MEMORY				LABEL			
s	a, ϕ_A	4	T_i, S_E	s		4	
t	n, ϕ_T	5	ΣT_i^2, S_A	t	√	5	
0	i, V_A	6	F_A	0		6	
1	j, V_E	7	ϕ_E	1	√	7	
2	T.., CT	8		2		8	
3	Σx_{ij}^2, S_T	9		3		9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64		−		64	96									
65	RM	5	65	05	97									
66		=		84	98									
67	x→M	4	55	04	99									
68	F	HLT	F	12	100									
69	RM	t	65	83	101									
70		−		64	102									
71	RM	s	65	82	103									
72	M+	7	75	07	104									
73	F	HLT	F	12	105									
74		÷		44	106									
75	RM	4	65	04	107									
76		↕		45	108									
77		=		84	109									
78	x→M	1	55	01	110									
79	F	HLT	F	12	111									
80	RM	3	65	03	112									
81	F	HLT	F	12	113									
82	RM	t	65	83	114									
83	F	HLT	F	12	115									
84	RM	0	65	00	116									
85		÷		44	117									
86	RM	1	65	01	118									
87	M+	6	75	06	119									
88		S/E		85	120									
89					121									
90					122									
91					123									
92					124									
93					125									
94					126									
95					127									

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **RANDOM NUMBER GENERATOR**

PROGRAM NO. P2–B–17

[Formula]

$$x_{n+1} = 23x_n - \mathrm{int}\left(\frac{23x_n}{10^8+1}\right) \times (10^8+1)$$

x_0: optional 8 digits integer

[Example]

Assumption $x_0 = 12345678$

[Operation]

	CA	
(x_0)	12345678	S/E (x_1) 83950592
		S/E (x_2) 30863597
		S/E (x_3) 9862724
		S/E (x_4) 26842650
		S/E (x_5) 17380944
		S/E (x_6) 99761709
		S/E (x_7) 94519285
		S/E (x_8) 73943534
		S/E (x_9) 701265
		S/E (x_{10}) 16129095
		S/E (x_{11}) 70969182
		S/E (x_{12}) 32291170
		S/E (x_{13}) 42696903
		S/E (x_{14}) 82028760
		S/E (x_{15}) 86661462
		S/E (x_{16}) 93213607
		S/E (x_{17}) 43912940
		S/E (x_{18}) 9997610
		S/E (x_{19}) 29945028

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		x→M	0	55 00	32				
1			EXP	41	33				
2			8	08	34				
3			+	74	35				
4			1	01	36				
5			=	84	37				
6		x→M	1	55 01	38				
7	F	LBL	1	F 13 01	39				
8		RM	0	65 00	40				
9			x	54	41				
10			2	02	42				
11			3	03	43				
12			=	84	44				
13		x→M	0	55 00	45				
14			÷	44	46				
15		RM	1	65 01	47				
16			=	84	48				
17		F	int	F 84	49				
18			x	54	50				
19		RM	1	65 01	51				
20			+/−	82	52				
21		M+	0	75 00	53				
22		RM	0	65 00	54				
23		F	HLT	F 12	55				
24		GTO	1	14 01	56				
25					57				
26					58				
27					59				
28					60				
29					61				
30					62				
31					63				

MEMORY

s		4	
t		5	
0	x_n	6	
1	$10^x + 1$	7	
2		8	
3		9	

LABEL

s		4	
t		5	
0		6	
1	√	7	
2		8	
3		9	

SHARP

ANGLE DESIGNATION: (DEG) RAD GRAD

TITLE: ANGLE CALCULATION

PROGRAM NO.: P2–C–1

[Formula]

This program computes the angle calculation by D. MS.

[Example]

123°45′12″+54°32′10″−30°20′10″=147°57′12″

[Operation]

	CA
123.4512	S/E
54.321	S/E 178.1722
30.2010	+/− S/E 147.5712

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0			DEG			21	32						
1		x↔M	0		55	00	33						
2	F	LBL	t	F	13	83	34						
3		RM	0		65	00	35						
4	F	GTS	0	F	14	00	36						
5		F	HLT		F	12	37						
6			DEG			21	38						
7		M+	0		75	00	39						
8		GTO	t		14	83	40						
9	F	LBL	0	F	13	00	41						
10	F	x<0	1	F	65	01	42						
11			+			74	43						
12		GTO	2		14	02	44						
13	F	LBL	1	F	13	01	45						
14			−			64	46						
15	F	LBL	2	F	13	02	47						
16			1			01	48						
17			EXP			41	49						
18			4			04	50						
19			+/−			82	51						
20			=			84	52						
21		F	D.MS		F	21	53						
22			x			54	54						
23			EXP			41	55						
24			4			04	56						
25			=			84	57						
26		F	int		F	84	58						
27			÷			44	59						
28			EXP			41	60						
29			4			04	61						
30			=			84	62						
31			S/E			85	63						

MEMORY

s		4	
t		5	
0	DEG	6	
1	D·MS	7	
2	√	8	
3		9	

LABEL

s		4	
t	√	5	
0	SUB	6	
1	√	7	
2	√	8	
3		9	

SHARP

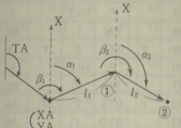
ANGLE DESIGNATION: (DEG) RAD GRAD

TITLE

OPEN TRAVERSE

PROGRAM NO. P2-C-2

[Formula]



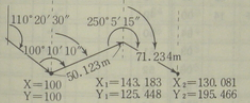
$\alpha_i = \alpha_{i-1} + \beta_i + 180° - (360°)$

$X_i = X_{i-1} + l_i \cos \alpha_i$

$Y_i = Y_{i-1} + l_i \sin \alpha_i$

This program computes the coordinates of an open traverse.
First of all, input the coordinate and field angles of the starting point, and then from the given angles and distances you will find the required field angles and coordinates.

[Example]



[Operation]

		CA	
(TA)	110.2030	S/E	
(XA)	100	S/E	
(YA)	100	S/E	
(β_1)	100.1010	S/E	
(l_1)	50.123	S/E	(α_1) 30.304
		S/E	(X_1) 143.183
		S/E	(Y_1) 125.448
(β_2)	250.0515	S/E	
(l_2)	71.234	S/E	(α_2) 100.3555
		S/E	(X_2) 130.081
		S/E	(Y_2) 195.466

STEP	KEY		KEY CODE			STEP	KEY		KEY CODE		
0		DEG			21	32		M+	1	75	01
1		x→M	0	55	00	33			‡		45
2		F	HLT	F	12	34		M+	2	75	02
3		x→M	1	55	01	35		RM	0	65	00
4		F	HLT	F	12	36	F	GTS	0	F	14	00
5		x→M	2	55	02	37		F	HLT	F	12
6	F	LBL	t	F	13	83	38		RM	1	65	01
7		F	HLT	F	12	39	F	GTS	2	F	14	02
8			DEG		21	40		F	HLT	F	12
9		M+	0	75	00	41		RM	2	65	02
10		F	HLT	F	12	42	F	GTS	2	F	14	02
11		x→M	3	55	03	43		GTO	t	14	83
12			1		01	44	F	LBL	0	F	13	00
13			8		08	45			+			74
14			0		00	46			1			01
15		M+	0	75	00	47			EXP			41
16		RM	0	65	00	48			4			04
17	F	GTS	0	F	14	00	49		+/−			82
18			−		64	50			=			84
19			3		03	51		F	D.MS	F		21
20			6		06	52			x			54
21			0		00	53			EXP			41
22			=		84	54			4			04
23	F	$x<0$	1	F	65	01	55		=			84
24			‡		45	56		F	int	F		84
25			+/−		82	57			÷			44
26		M+	0	75	00	58			EXP			41
27	F	LBL	1	F	13	01	59		4			04
28		RM	3	65	03	60			=			84
29			‡		45	61			S/E			85
30		RM	0	65	00	62	F	LBL	2	F	13	02
31		F	$\rightarrow xy$	F	74	63			x			54

MEMORY

s		4	
t		5	
0	α_t	6	
1	X_t	7	
2	Y_t	8	
3	θ_t	9	

LABEL

s		4	√
t	√	5	
0	D·MS SUB	6	
1	√	7	
2	TAB=3 SUB	8	
3	√	9	

STEP	KEY		KEY CODE			STEP	KEY		KEY CODE		
64		EXP			41	96					
65		3			03	97					
66		=			84	98					
67	F	$x<0$	3	F	65	03	99				
68		+			74	100					
69		GTO	4		14	04	101				
70	F	LBL	3	F	13	03	102				
71		−			64	103					
72	F	LBL	4	F	13	04	104				
73		·			83	105					
74		5			05	106					
75		=			84	107					
76	F	int		F	84	108					
77		x			54	109					
78		EXP			41	110					
79		3			03	111					
80		+/−			82	112					
81		=			84	113					
82		S/E			85	114					
83						115					
84						116					
85						117					
86						118					
87						119					
88						120					
89						121					
90						122					
91						123					
92						124					
93						125					
94						126					
95						127					

NOTE

SHARP

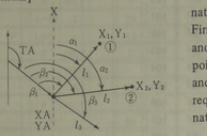
ANGLE DESIGNATION
(DEG) RAD GRAD

PROGRAM NO.
P2-C-3

TITLE **RADIATE TRAVERSE**

This program computes the coordinate by radiate traverse.
First of all, input the coordinate and field angles of the starting point and then from the given angles and distances you will find the required field angles and coordinates.

[Formula]

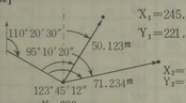


$\alpha_i = TA + \beta_i + 180^\circ - (360^\circ)$

$X_i = XA + l_i \cos \alpha_i$

$Y_i = YA + l_i \sin \alpha_i$

[Example]



$X_1 = 245.235$m
$Y_1 = 221.589$m

$X_2 = 241.775$m
$Y_2 = 257.699$m

[Operation]

	CA	
(TA) 110.2030	S/E	
(XA) 200	S/E	
(YA) 200	S/E	
(β_1) 95.1020	S/E	
(l_1) 50.123	S/E	(α_1) 25.305
	S/E	(X_1) 245.235
	S/E	(Y_1) 221.589
(β_2) 123.4512	S/E	
(l_2) 71.234	S/E	(α_2) 54.0542
	S/E	(X_2) 241.775
	S/E	(Y_2) 257.699

STEP	KEY		KEY CODE			STEP	KEY		KEY CODE		
0		DEG			21	32	F	LBL	1	F	13	01
1		x→M	4		55	33		RM	0		65	00
2		F	HLT		F	34	F	GTS	0	F	14	00
3		x→M	1		55	35		F	HLT		F	12
4		F	HLT		F	36		RM	0		65	00
5		x→M	2		55	37			cos			23
6	F	LBL	t	F	13	38			x			54
7		F	HLT		F	39		RM	3		65	03
8			DEG			40			+			74
9			+			41		RM	1		65	01
10		RM	4		65	42			=			84
11			=			43	F	GTS	2	F	14	02
12		x→M	0		55	44		F	HLT		F	12
13		F	HLT		F	45		RM	0		65	00
14		x→M	3		55	46			sin			22
15			1		01	47			x			54
16			8		08	48		RM	3		65	03
17			0		00	49			+			74
18		M+	0		75	00		RM	2		65	02
19		RM	0		65	00			=			84
20	F	GTS	0	F	14	00	F	GTS	2	F	14	02
21			–			64		GTO	t		14	83
22			3			03	F	LBL	0	F	13	00
23			6			06			+			74
24			0			00			5			05
25			=			84			EXP			41
26	F	$x<0$	1	F	65	01			5			05
27			3			03			+/–			82
28			6			06			=			84
29			0			00		F	D.MS		F	21
30			+/–			82			x			54
31		M+	0		75	00			EXP			41

MEMORY				LABEL			
s		4	TA	s		4	√
t		5		t	√	5	
0	α_i	6		0	D·MS SUB	6	
1	XA	7		1	√	7	
2	YA	8		2	TAB=3 SUB	8	
3	l_i	9		3	√	9	

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64			4			04	96						
65			=			84	97						
66		F	int		F	84	98						
67			÷			44	99						
68			EXP			41	100						
69			4			04	101						
70			=			84	102						
71			S/E			85	103						
72	F	LBL	2	F	13	02	104						
73			x			54	105						
74			EXP			41	106						
75			3			03	107						
76			=			84	108						
77	F	x<0	3	F	65	03	109						
78			+			74	110						
79		GTO	4		14	04	111						
80	F	LBL	3	F	13	03	112						
81			−			64	113						
82	F	LBL	4	F	13	04	114						
83			·			83	115						
84			5			05	116						
85			=			84	117						
86		F	int		F	84	118						
87			x			54	119						
88			EXP			41	120						
89			3			03	121						
90			+/−			82	122						
91			=			84	123						
92			S/E			85	124						
93							125						
94							126						
95							127						

NOTE

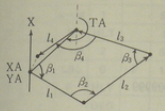
SHARP

ANGLE DESIGNATION: (DEG) RAD GRAD

TITLE **CLOSED TRAVERSE**

PROGRAM NO. P2–C–4

[Formula]



This program computes the coordinate by closed traverse.
First of all, input the difference of coordinate and field angles of the starting point and then from the angles and distances you will find the error of closure and the corrected coordinates.

$$\Sigma\triangle X_i = EX$$
$$\Sigma\triangle Y_i = EY$$

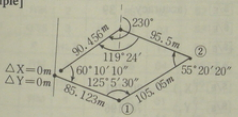
Sum of distance ; Σl_i

accuracy ; $\Sigma l_i \,/\sqrt{(\Sigma\triangle X_i)^2+(\Sigma\triangle Y_i)^2}$

$$X_i = X_{i-1}+\triangle X_i+\frac{l_i}{\Sigma l_i}EX$$

$$Y_i = Y_{i-1}+\triangle Y_i+\frac{l_i}{\Sigma l_i}EY$$

[Example]



EX = 5.968m
EY = 7.542m
accuracy 39

β_i	l_i	α_i	X_i	Y_i
		230°	0 m	0 m
60°10′10″	85.123m	110°10′10″	−30.701	78.196
125° 5′30″	105.05	55°15′40″	27.494	162.416
55°20′20″	95.5	290°36′	59.579	71.107
119°24′	90.456	230°	0	0

Sum of distance 376.129

SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD

TITLE
CLOSED TRAVERSE

PROGRAM NO.
P2-C-4

[Operation]

	CA	
(TA) 230	S/E	
(△X) 0	S/E	
(△X) 0	S/E	
(β_1) 60.1010	S/E	
(l_1) 85.123	S/E	(a_1) 110.1009999
(β_2) 125.0530	S/E	
(l_2) 105.05	S/E	(a_2) 55.15399999
(β_3) 55.2020	S/E	
(l_3) 95.5	S/E	(a_3) 290.3559999
(β_4) 119.24	S/E	
(l_4) 90.456	S/E	(a_4) 229.5959999
0	S/E	(EX) 5.968
	S/E	(EY) 7.542
	S/E	($\sum l_i$) 376.129
	S/E	(accuracy) 39
(XA) 0	S/E	
(YA) 0	S/E	
(β_1) 60.1010	S/E	
(l_1) 85.123	S/E	(X_1) −30.701
	S/E	(Y_1) 78.196
(β_2) 125.0530	S/E	
(l_2) 105.05	S/E	(X_2) 27.494
	S/E	(Y_2) 162.416
(β_3) 55.2020	S/E	
(l_3) 95.5	S/E	(X_3) 59.579
	S/E	(Y_3) 71.107
(β_4) 119.24	S/E	
(l_4) 90.456	S/E	(X_4) 0
	S/E	(Y_4) 0

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0		F	CAM		F	45	32			=			84
1			DEG			21	33			+/−			82
2		x→M	0		55	00	34		x→M	9		55	09
3		x→M	5		55	05	35		RM	5		65	05
4		F	HLT		F	12	36		x→M	0		55	00
5		x→M	1		55	01	37		RM	8		65	08
6		F	HLT		F	12	38		F	x^2		F	44
7		x→M	2		55	02	39			+			74
8	F	LBL	0	F	13	00	40		RM	9		65	09
9		F	HLT		F	12	41		F	x^2		F	44
10			DEG			21	42			=			84
11		M+	0		75	00	43		F	$\sqrt{\ }$		F	42
12	F	$x=t$	1	F	75	01	44		F	$1/x$		F	43
13	F	GTS	2	F	14	02	45		F	int		F	84
14	F	LBL	8	F	13	08	46		F	HLT		F	12
15		GTO	0		14	00	47		x→M	1		55	01
16	F	LBL	1	F	13	01	48		F	HLT		F	12
17		RM	1		65	01	49		x→M	2		55	02
18	F	GTS	3	F	14	03	50	F	LBL	4	F	13	04
19		F	HLT		F	12	51		F	HLT		F	12
20		RM	2		65	02	52			DEG			21
21	F	GTS	3	F	14	03	53		M+	0		75	00
22		F	HLT		F	12	54	F	GTS	2	F	14	02
23		RM	4		65	04	55		RM	3		65	03
24		F	HLT		F	12	56			x			54
25		RM	1		65	01	57		RM	8		65	08
26			÷			44	58		M+	1		75	01
27		RM	4		65	04	59		RM	3		65	03
28			=			84	60			x			54
29			+/−			82	61		RM	9		65	09
30		x→M	8		55	08	62		M+	2		75	02
31		RM	2		65	02	63		GTO	t		14	83

MEMORY					LABEL				
s		4	$\Sigma \varrho_i$		s		4	√	
t		5	T_A		t	√	5	√	
0	T_A	6	X_A		0	√	6	√	
1	X_0	7	Y_A		1	√	7	√	
2	Y_0	8	ϵx		2	SUB	8	√	
3	ϱ_i	9	ϵy		3	TAB=3	9		

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64	F	LBL	t	F	13	83	96	F	LBL	5	F	13	05
65		RM	1		65	01	97		RM	3		65	03
66	F	GTS	3	F	14	03	98			↕			45
67		F	HLT		F	12	99		RM	0		65	00
68		RM	2		65	02	100		F	→xy		F	74
69	F	GTS	3	F	14	03	101		M+	1		75	01
70		GTO	4		14	04	102			↕			45
71	F	LBL	2	F	13	02	103		M+	2		75	02
72		F	HLT		F	12	104		RM	0		65	00
73		x→M	3		55	03	105		F	D.MS		F	21
74		M+	4		75	04	106			S/E			85
75			1			01	107	F	LBL	3	F	13	03
76			8			08	108			x			54
77			0			00	109			EXP			41
78		M+	0		75	00	110			3			03
79		RM	0		65	00	111			=			84
80			+			74	112	F	x<0	6	F	65	06
81			1			01	113			+			74
82			EXP			41	114		GTO	7		14	07
83			4			04	115	F	LBL	6	F	13	06
84			+/−			82	116			−			64
85			=			84	117	F	LBL	7	F	13	07
86		F	D.MS		F	21	118			·			83
87			−			64	119			5			05
88			3			03	120			=			84
89			6			06	121		F	int		F	84
90			0			00	122			÷			44
91			=			84	123			EXP			41
92	F	x<0	5	F	65	05	124			3			03
93			↕			45	125			=			84
94			+/−			82	126			S/E			85
95		M+	0		75	00	127						

NOTE

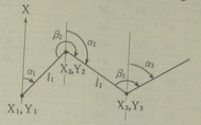
SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD
PROGRAM NO. P2−C−5

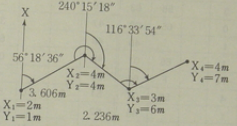
TITLE **INVERSE FROM COORDINATES**

[Formula]

This program calculates distance and field angles from the coordinates.



[Example]



[Operation]

		CA		
(X_1)	2	S/E		
(Y_1)	1	S/E		
(X_2)	4	S/E		
(Y_2)	4	S/E	(α_1)	56.1836
		S/E	(l_1)	3.606
(X_3)	3	S/E		
(Y_3)	6	S/E	(β_2)	240.1518
		S/E	(α_2)	116.3354
		S/E	(l_2)	2.236
(X_4)	4	S/E		
(Y_4)	7	S/E	(β_1)	108.2606
		S/E	(α_3)	45
		S/E	(l_3)	1.414

⋮

STEP	KEY		KEY CODE			STEP	KEY		KEY CODE		
0		F	CAM		45	32		$x \rightarrow M$	9		55	09
1			+/−		82	33		GTO	3		14	03
2		$x \rightarrow M$	0		00	34	F	LBL	2	F	13	02
3		F	HLT		12	35		RM	5		65	05
4			+/−		82	36			−			64
5		$x \rightarrow M$	1		01	37		RM	6		65	06
6	F	LBL	t	F	83	38			+			74
7		F	HLT		12	39			1			01
8		M+	0		00	40			8			08
9			+/−		82	41			0			00
10		$x \rightarrow M$	2		02	42			=			84
11		F	HLT		12	43		$x \rightarrow M$	7		55	07
12		M+	1		01	44	F	$x<0$	4	F	65	04
13			+/−		82	45	F	GTS	6	F	14	06
14		$x \rightarrow M$	3		03	46			−			64
15		RM	0		00	47			3			03
16			↕		45	48			6			06
17		RM	1		01	49			0			00
18		F	$\rightarrow\theta$		64	50			=			84
19		$x \rightarrow M$	4		04	51	F	$x<0$	5	F	65	05
20			↕		45	52			DEG			21
21		$x \rightarrow M$	5		05	53		$x \rightarrow M$	7		55	07
22			+/−		82	54		GTO	5		14	05
23	F	$x<0$	1	F	01	55	F	LBL	4	F	13	04
24			3		03	56			3			03
25			6		06	57			6			06
26			0		00	58			0			00
27		M+	5		05	59		M+	7		75	07
28	F	LBL	1	F	01	60	F	LBL	5	F	13	05
29		RM	9		09	61		RM	7		65	07
30	F	$x \neq 0$	2	F	02	62	F	GTS	6	F	14	06
31			1		01	63		F	HLT		F	12

MEMORY

s		4	r
t		5	α_l
0	ΔX	6	α_{l-1}
1	ΔY	7	β
2	X_l	8	
3	Y_l	9	√

LABEL

s		4	√
t	√	5	√
0		6	D.MS
1	√	7	TAB = 3
2	√	8	
3	√	9	

STEP	KEY		KEY CODE			STEP	KEY		KEY CODE		
64	F	LBL	3	F	03	96	F	LBL	7	F	07
65		RM	5		05	97			×		54
66		$x \rightarrow M$	6		06	98			EXP		41
67		RM	2		02	99			3		03
68		$x \rightarrow M$	0		00	100			+		74
69		RM	3		03	101			·		83
70		$x \rightarrow M$	1		01	102			5		05
71		RM	5		05	103			=		84
72	F	GTS	6	F	06	104		F	int	F	84
73		F	HLT		12	105			÷		44
74		RM	4		04	106			EXP		41
75	F	GTS	7	F	07	107			3		03
76		GTO	t		83	108			=		84
77	F	LBL	6	F	06	109			S/E		85
78			+		74	110					
79			5		05	111					
80			EXP		41	112					
81			5		05	113					
82			+/−		82	114					
83			DEG		21	115					
84			=		84	116					
85		F	D.MS		21	117					
86			×		54	118					
87			EXP		41	119					
88			4		04	120					
89			=		84	121					
90		F	int		84	122					
91			÷		44	123					
92			EXP		41	124					
93			4		04	125					
94			=		84	126					
95			S/E		85	127					

NOTE

SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD

TITLE

AREA BY COORDINATES

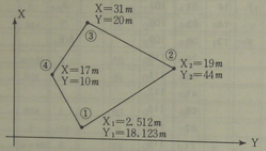
PROGRAM NO. P2-C-6

[Formula]

This program calculates the area by coordinates.

$$2S = \sum\{(X_{i-1} - X_{i+1})Y_i\}$$

[Example]



[Operation]

	CA		
(X_1) 2.512	S/E		
(X_2) 19	S/E		
(Y_2) 44	S/E		
(X_3) 31	S/E		
(Y_3) 20	S/E	$(X_1-X_3)Y_2$	−1253.472
(X_4) 17	S/E		
(Y_4) 10	S/E	$(X_2-X_4)Y_3$	40
(X_1) 2.512	S/E		
(Y_1) 18.123	S/E	$(X_3-X_1)Y_4$	284.88
	GTO 2 S/E	$(X_4-X_2)Y_1$	−36.246
	S/E	$2\Sigma S$	− 964.838
	S/E	ΣS	482.419

STEP	KEY		KEY CODE	STEP	KEY		KEY CODE
0	F	CAM	F 45	32	RM	4	65 04
1	x→M	1	55 01	33	M+	0	75 00
2	F	HLT	F 12	34	F	HLT	F 12
3	x→M	2	55 02	35	RM	0	65 00
4	x→M	3	55 03	36	F	HLT	F 12
5	F	HLT	F 12	37		÷	44
6	x→M	4	55 04	38		2	02
7	F LBL	t	F 13 83	39		=	84
8	F	HLT	F 12	40	F	abs	F 82
9	x→M	5	55 05	41		S/E	85
10	F	HLT	F 12	42			
11	x→M	6	55 06	43			
12	RM	1	65 01	44			
13		−	64	45			
14	RM	5	65 05	46			
15		x	54	47			
16	RM	4	65 04	48			
17	M+	0	75 00	49			
18	x→M	7	55 07	50			
19	RM	2	65 02	51			
20	x→M	1	55 01	52			
21	RM	5	65 05	53			
22	x→M	2	55 02	54			
23	RM	6	65 06	55			
24	x→M	4	55 04	56			
25	RM	7	65 07	57			
26	GTO	t	14 83	58			
27	F LBL	2	F 13 02	59			
28	RM	1	65 01	60			
29		−	64	61			
30	RM	3	65 03	62			
31		x	54	63			

MEMORY

s		4	Y_i
t		5	X_{i+1}
0	$2\Sigma S$	6	Y_{i+1}
1	X_{i-1}	7	$2S$
2	X_i	8	
3	X_i	9	

LABEL

s		4
t	√	5
0		6
1		7
2	√	8
3		9

SHARP

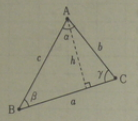
ANGLE DESIGNATION
(DEG) RAD GRAD

TITLE
TRIANGLE SOLUTION 1

PROGRAM NO.
P2-C-7

[Formula]

This program solves the triangle by the following formulas. (a, b, c; known)



$$\alpha = \cos^{-1}\frac{b^2+c^2-a^2}{2bc}$$

$$\beta = \cos^{-1}\frac{a^2+c^2-b^2}{2ac}$$

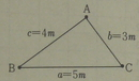
$$\gamma = 180 - \alpha - \beta$$

$$S = \sqrt{s(s-a)(s-b)(s-c)}$$

$$s = \frac{a+b+c}{2}$$

$$h = \frac{2S}{MAX\{a, b, c\}}$$

[Example]



$\alpha = 90°$

$\beta = 36°\ 52'\ 12''$

$\gamma = 53°\ 7'\ 48''$

$S = 6\ m^2$

$h = 2.4m$

[Operation]

CA

(a) 5 S/E

(b) 3 S/E

(c) 4 S/E (S) 6

S/E (h) 2.4

S/E (α) 90

S/E (β) 36.5212

S/E (γ) 53.0748

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	1	55	01	32		5		05
1	x→M	4	55	04	33		=		84
2	F	HLT	F	12	34	F	int	F	84
3	x→M	2	55	02	35		x		54
4	x→M	5	55	05	36		EXP		41
5	F	HLT	F	12	37		6		06
6	x→M	3	55	03	38		+/−		82
7	x→M	6	55	06	39		=		84
8		+		74	40	F	HLT	F	12
9	RM	2	65	02	41	x→M	4	55	04
10		+		74	42	RM	1	65	01
11	RM	1	65	01	43	x→M	t	55	83
12		÷		44	44	RM	2	65	02
13		2		02	45 F	x<t	1 F	85	01
14		=		84	46	RM	2	65	02
15		+/−		82	47	x→M	t	55	83
16	M+	4	75	04	48 F	LBL	1 F	13	01
17	M+	5	75	05	49	RM	3	65	03
18	M+	6	75	06	50 F	x<t	2 F	85	02
19		x		54	51	RM	3	65	03
20	RM	4	65	04	52	x→M	t	55	83
21		x		54	53 F	LBL	2 F	13	02
22	RM	5	65	05	54	RM	4	65	04
23		x		54	55		x		54
24	RM	6	65	06	56		2		02
25		=		84	57		÷		44
26	F	√	F	42	58	RM	t	65	83
27		x		54	59		=		84
28		EXP		41	60	F	HLT	F	12
29		6		06	61	RM	2	65	02
30		+		74	62	F	x^3	F	44
31		·		83	63		+		74

MEMORY				LABEL			
s		4	S, S'	s		4	
t	MAX {a, b, c}	5	α + β	t	√	5	
0		6		0		6	
1	a	7		1	√	7	
2	b	8		2	√	8	
3	c	9		3	D·MS SUB	9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64	RM	3	65	03	96	M+	5	75	05					
65	F	x^2	F	44	97	F GTS	3	F 14	03					
66		−	64		98	F	HLT	F	12					
67	RM	1	65	01	99		1		01					
68	F	x^2	F	44	100		8		08					
69		÷	44		101		0		00					
70		2	02		102		−		64					
71		÷	44		103	RM	5	65	05					
72	RM	2	65	02	104		=		84					
73		÷	44		105	F GTS	3	F 14	03					
74	RM	3	65	03	106		S/E		85					
75		=	84		107	F LBL	3	F 13	03					
76	F	$\cos^{-1}$	F	23	108		+		74					
77	x→M	5	55	05	109		5		05					
78	F GTS	3	F 14	03	110		EXP		41					
79	F	HLT	F	12	111		5		05					
80	RM	1	65	01	112		+/−		82					
81	F	x^2	F	44	113		DEG		21					
82		+	74		114		=		84					
83	RM	3	65	03	115	F	D.MS	F	21					
84	F	x^2	F	44	116		×		54					
85		−	64		117		EXP		41					
86	RM	2	65	02	118		4		04					
87	F	x^2	F	44	119		=		84					
88		÷	44		120	F	int	F	84					
89		2	02		121		÷		44					
90		÷	44		122		EXP		41					
91	RM	1	65	01	123		4		04					
92		÷	44		124		=		84					
93	RM	3	65	03	125		S/E		85					
94		=	84		126									
95	F	$\cos^{-1}$	F	23	127									

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

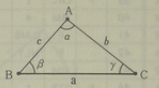
TITLE **TRIANGLE SOLUTION 2**

PROGRAM NO. P2–C–8

[Formula]

This program solves the triangle by the following formulas. (a, β, γ: known)

$$\alpha = 180 - (\beta + \gamma)$$

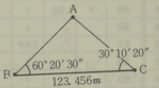


$$b = \frac{a}{\sin \alpha} \sin \beta$$

$$c = \frac{a}{\sin \alpha} \sin \gamma$$

$$S = \frac{1}{2} ab \sin \gamma$$

[Example]



[Operation]

	CA	
(a)	123.456 S/E	
(β)	60.2030 S/E	
(γ)	30.1020 S/E	(γ) 89.291
	S/E	(b) 107.287
	S/E	(c) 62.057
	S/E	(S) 3328.516325

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	F	CAM	F	45	32		=		84
1	x→M	1	55	01	33		×		54
2		1		01	34	RM	1	65	01
3		8		08	35		÷		44
4		0		00	36		2		02
5	x→M	4	55	04	37	M+	8	75	08
6	F	HLT	F	12	38	GTO	t	14	83
7		DEG		21	39	F LBL	t	F 13	83
8	x→M	2	55	02	40	RM	4	65	04
9		+/−		82	41	F	D.MS	F	21
10	M+	4	75	04	42	F	HLT	F	12
11	F	HLT	F	12	43	RM	6	65	06
12		DEG		21	44	F GTS	1	F 14	01
13	x→M	3	55	03	45	RM	7	65	07
14		+/−		82	46	F GTS	1	F 14	01
15	M+	4	75	04	47	RM	8	65	08
16	RM	1	65	01	48		S/E		85
17		÷		44	49	F LBL	1	F 13	01
18	RM	4	65	04	50		x		54
19		sin		22	51		EXP		41
20	M+	5	75	05	52		3		03
21		x		54	53		+		74
22	RM	2	65	02	54		·		83
23		sin		22	55		5		05
24	M+	6	75	06	56		=		84
25	RM	3	65	03	57	F	int	F	84
26		sin		22	58		÷		44
27		x		54	59		EXP		41
28	RM	5	65	05	60		3		03
29		=		84	61		=		84
30	x→M	7	55	07	62	F	HLT	F	12
31	RM	6	65	06	63		S/E		85

MEMORY

s		4	α
t		5	a/sin α
0		6	b
1	a	7	c
2	β	8	
3	γ	9	

LABEL

s		4	
t	√	5	
0		6	
1	TAB = 3	7	
2		8	
3		9	

SHARP

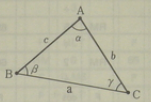
ANGLE DESIGNATION
(DEG) RAD GRAD

TITLE **TRIANGLE SOLUTION 3**

PROGRAM NO. P2–C–9

[Formula]

This program solves the triangle by the following formulas.
(b, c, α ; known)



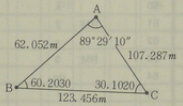
$$a=\sqrt{b^2+c^2-2bc\cos\alpha}$$

$$\beta=\cos^{-1}\frac{a^2+c^2-b^2}{2ac}$$

$$\gamma=180-\alpha-\beta$$

$$S=\frac{1}{2}bc\sin\alpha$$

[Example]



S=3328.5525·····(m²)

[Operation]

CA

(b) 107.287 S/E

(c) 62.052 S/E

(α) 89.2910 S/E (a) 123.457

S/E (β) 60.20297892 (60°20'29"7892)

S/E (γ) 30.10202107 (30°10'20"2107)

S/E (S) 3328.552577

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	F	CAM	F	45	32		+		74
1	x→M	1	55	01	33	RM	2	65	02
2	F	HLT	F	12	34	F	x^2	F	44
3	x→M	2	55	02	35		−		64
4	F	HLT	F	12	36	RM	1	65	01
5		DEG		21	37	F	x^3	F	44
6	x→M	3	55	03	38		÷		44
7		+/−		82	39		2		02
8	x→M	4	55	04	40		÷		44
9		1		01	41	RM	5	65	05
10		8		08	42		÷		44
11		0		00	43	RM	2	65	02
12	M+	4	75	04	44		=		84
13		2		02	45	F	$\cos^{-1}$	F	23
14		x		54	46	x→M	6	55	06
15	RM	1	65	01	47		+/−		82
16		x		54	48	M+	4	75	04
17	RM	2	65	02	49	RM	1	65	01
18		x		54	50		x		54
19	RM	3	65	03	51	RM	2	65	02
20		cos		23	52		x		54
21		+/−		82	53	RM	3	65	03
22		+		74	54		sin		22
23	RM	1	65	01	55		÷		44
24	F	x^2	F	44	56		2		02
25		+		74	57		=		84
26	RM	2	65	02	58	x→M	7	55	07
27	F	x^2	F	44	59	GTO	t	14	83
28		=		84	60	F LBL	t	F 13	83
29	F	$\sqrt{}$	F	42	61	RM	5	65	05
30	x→M	5	55	05	62		x		54
31	F	x^3	F	44	63		EXP		41

MEMORY

s			4	γ	s			4	
t			5	a	t	√		5	
0			6	β	0			6	
1	b		7	s	1			7	
2	c		8		2			8	
3	α		9		3			9	

LABEL

STEP	KEY		KEY CODE		STEP	KEY	KEY CODE
64		3		03	96		
65		+		74	97		
66		•		83	98		
67		5		05	99		
68		=		84	100		
69	F	int	F	84	101		
70		÷		44	102		
71		EXP		41	103		
72		3		03	104		
73		=		84	105		
74	F	HLT	F	12	106		
75	RM	6	65	06	107		
76	F	D.MS	F	21	108		
77	F	HLT	F	12	109		
78	RM	4	65	04	110		
79	F	D.MS	F	21	111		
80	F	HLT	F	12	112		
81	RM	7	65	07	113		
82		S/E		85	114		
83					115		
84					116		
85					117		
86					118		
87					119		
88					120		
89					121		
90					122		
91					123		
92					124		
93					125		
94					126		
95					127		

NOTE

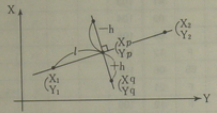
SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD
PROGRAM NO.
P2-C-10

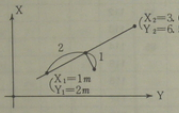
TITLE **POINT OF MOVED PARALLEL**

[Formula]

This program calculates the coordinate of moved parallel by two points, moved distance and vertical distance.



[Example]



(X2=3.625m Y2=6.512m)

(Xp=2.006m Yp=3.729m)

(Xq=1.141m Yq=4.232m)

[Operation]

	CA	
(X_1)	1 S/E	
(Y_1)	2 S/E	
(X_2)	3.625 S/E	
(Y_2)	6.512 S/E	
(l)	2 S/E	
(h)	1 S/E (X_p)	2.006
	S/E (Y_p)	3.729
	S/E (X_q)	1.141
	S/E (Y_q)	4.232

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	1	55	01	32	M+	9	75	09
1	+/−			82	33	RM	8	65	08
2	x→M	3	55	03	34	x→M	s	55	82
3	F	HLT	F	12	35	RM	9	65	09
4	x→M	2	55	02	36	x→M	t	55	83
5	+/−			82	37		2		02
6	x→M	4	55	04	38		7		07
7	F	HLT	F	12	39		0		00
8	M+	3	75	03	40	M+	7	75	07
9	F	HLT	F	12	41	RM	6	65	06
10	M+	4	75	04	42	F x<0	1	F 65	01
11	F LBL	t	F 13	83	43		1		01
12	F	HLT	F	12	44		8		08
13	x→M	5	55	05	45		0		00
14	F	HLT	F	12	46		+/−		82
15	x→M	6	55	06	47	M+	7	75	07
16	RM	1	65	01	48	F LBL	1	F 13	01
17	x→M	8	55	08	49	RM	6	65	06
18	RM	2	65	02	50	F	abs	F	82
19	x→M	9	55	09	51		‡		45
20	RM	3	65	03	52	RM	7	65	07
21		‡		45	53	F	→xy	F	74
22	RM	4	65	04	54	M+	s	75	82
23	F	→rθ	F	64	55		‡		45
24		‡		45	56	M+	t	75	83
25	x→M	7	55	07	57	RM	8	65	08
26		‡		45	58	F GTS	2	F 14	02
27	RM	5	65	05	59	F	HLT	F	12
28		‡		45	60	RM	9	65	09
29	F	→xy	F	74	61	F GTS	2	F 14	02
30	M+	8	75	08	62	F	HLT	F	12
31		‡		45	63	RM	s	65	82

MEMORY				LABEL			
s	X_2	4	ΔY	s		4	√
t	Y_2	5	ℓ	t	√	5	
0		6	+/− h	0		6	
1	X1	7	θ	1	√	7	
2	Y1	8	Xp	2	SUB	8	
3	ΔX	9	Yp	3	√	9	

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64	F	GTS	2	F	14	02	96						
65		F	HLT		F	12	97						
66		RM	t		65	83	98						
67	F	GTS	2	F	14	02	99						
68		GTO	t		14	83	100						
69	F	LBL	2	F	13	02	101						
70			x			54	102						
71			EXP			41	103						
72			3			03	104						
73			=			84	105						
74	F	$x<0$	3	F	65	03	106						
75			+			74	107						
76		GTO	4		14	04	108						
77	F	LBL	3	F	13	03	109						
78			−			64	110						
79	F	LBL	4	F	13	04	111						
80			·			83	112						
81			5			05	113						
82			=			84	114						
83		F	int		F	84	115						
84			x			54	116						
85			EXP			41	117						
86			3			03	118						
87			+/−			82	119						
88			=			84	120						
89			S/E			85	121						
90							122						
91							123						
92							124						
93							125						
94							126						
95							127						

NOTE

SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD

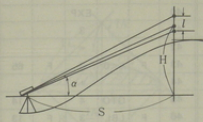
TITLE

STADIA SURVEYING

PROGRAM NO.
P2–C–11

[Formula]

This program computes the horizontal distance (S) and the height (H) from the given difference l and measuring angle α.



$$S = Kl\cos^2\alpha + C\cos\alpha$$

$$H = \frac{1}{2}Kl\sin 2\alpha + C\sin\alpha$$

[Example]

when $\begin{cases} K=100,\ C=0.3 \\ l=1.325\text{m} \quad \alpha=8°47', \quad S=129.707\text{m} \\ \qquad\qquad\qquad\qquad H=20.041\text{m} \end{cases}$

[Operation]

(K) 100 [GTO] [2] [S/E]) initial condition
(C) 0.3 [S/E])
[CA]

(l) 1.325 [S/E]

(α) 8.47 [S/E] (S) 129.707

[S/E] (H) 20.041

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	3	55	03	32	MR	5	65	05
1	F	HLT	F	12	33	F GTS	1	F 14	01
2		DEG		21	34	F	HLT	F	12
3	x→M	4	55	04	35	RM	6	65	06
4		cos		23	36	F GTS	1	F 14	01
5	F	x^2	F	44	37		S/E		85
6		x		54	38	F LBL	1	F 13	01
7	RM	1	65	01	39		x		54
8		x		54	40		EXP		41
9	RM	3	65	03	41		3		03
10		=		84	42		=		84
11	x→M	5	55	05	43	F $x<0$	3	F 65	03
12	RM	4	65	04	44		+		74
13		x		54	45		GTO	4	14	04
14		2		02	46	F LBL	3	F 13	03
15		=		84	47		−		64
16		sin		22	48	F LBL	4	F 13	04
17		x		54	49		·		83
18	RM	1	65	01	50		5		05
19		x		54	51		=		84
20	RM	3	65	03	52	F	int	F	84
21		÷		44	53		x		54
22		2		02	54		EXP		41
23		=		84	55		3		03
24	x→M	6	55	06	56		+/−		82
25	RM	2	65	02	57		=		84
26		↕		45	58		S/E		85
27	RM	4	65	04	59	F LBL	2	F 13	02
28	F	→xy	F	74	60	x→M	1	55	01
29	M+	5	75	05	61	F	HLT	F	12
30		↕		45	62	x→M	2	55	02
31	M+	6	75	06	63		S/E		85

MEMORY

s		4	α
t		5	S
0		6	H
1	K	7	
2	c	8	
3	ℓ	9	

LABEL

s		4	√
t	√	5	
0		6	
1	TAB = 3 SUB	7	
2	2 PRO	8	
3	√	9	

SHARP

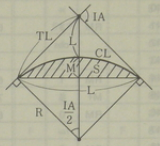
ANGLE DESIGNATION: (DEG) RAD GRAD

TITLE: SINGLE CURVE

PROGRAM NO.: P2–C–12

[Formula]

This program calculates the various elements from the intersection angle and radius. (R, IA: known)



$TL = R \tan\frac{IA}{2}$

$CL = R\frac{\pi}{180}IA$

$L = 2R \sin\frac{IA}{2}$

$SL = R(\sec\frac{IA}{2} - 1)$

$M = R(1 - \cos\frac{IA}{2})$

$S = \frac{R^2}{2}(\frac{\pi \cdot IA}{180} - \sin IA)$

[Example]

R = 100m
IA = 36°20′

TL = 32.8139m
CL = 63.4136m
L = 62.3564m
SL = 5.2461m
M = 4.9846m
S = 208.2717m²

[Operation]

CA

(R) 100 S/E

(IA) 36.20 S/E (TL) 32.8139
S/E (CL) 63.4136
S/E (L) 62.3564
S/E (SL) 5.2461
S/E (M) 4.9846
S/E (S) 208.2717

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	F	CAM	F	45	32		cos		23	64	RM	7	65	07
1	x→M	1	55	01	33	F	1/x	F	43	65	F GTS	1	F 14	01
2	F	HLT	F	12	34		−		64	66	RM	8	65	08
3		DEG		21	35		1		01	67	F GTS	1	F 14	01
4	x→M	2	55	02	36		x		54	68	RM	9	65	09
5		÷		44	37	RM	1	65	01	69	F GTS	1	F 14	01
6		2		02	38	M+	7	75	07	70		S/E		85
7	M+	3	75	03	39		1		01	71	F LBL	1	F 13	01
8	RM	1	65	01	40		−		64	72		x		54
9		x		54	41	RM	3	65	03	73		EXP		41
10	RM	3	65	03	42		cos		23	74		4		04
11		tan		24	43		x		54	75		+		74
12	M+	4	75	04	44	RM	1	65	01	76		-		83
13	F	π	F	41	45	M+	8	75	08	77		5		05
14		÷		44	46	RM	0	65	00	78		=		84
15		1		01	47		−		64	79	F	int	F	84
16		8		08	48	RM	2	65	02	80		÷		44
17		0		00	49		sin		22	81		EXP		41
18		x		54	50		x		54	82		4		04
19	RM	2	65	02	51	RM	1	65	01	83		=		84
20	M+	0	75	00	52	F	x^2	F	44	84	F	HLT	F	12
21		x		54	53		÷		44	85		S/E		85
22	RM	1	65	01	54		2		02	86				
23	M+	5	75	05	55	M+	9	75	09	87				
24		2		02	56	GTO	t	14	83	88				
25		x		54	57	F LBL	t	F 13	83	89				
26	RM	1	65	01	58	RM	4	65	04	90				
27		x		54	59	F GTS	1	F 14	01	91				
28	RM	3	65	03	60	RM	5	65	05	92				
29		sin		22	61	F GTS	1	F 14	01	93				
30	M+	6	75	06	62	RM	6	65	06	94				
31	RM	3	65	03	63	F GTS	1	F 14	01	95				

MEMORY			
s		4	TL
t		5	CL
0	$\frac{\pi}{180}$ / A	6	L
1	R	7	SL
2	A	8	M
3	A/2	9	S'

LABEL			
s		4	
t	√	5	
0		6	
1		7	
2		8	
3		9	

STEP	KEY	KEY CODE	STEP	KEY	KEY CODE
96			127		

NOTE

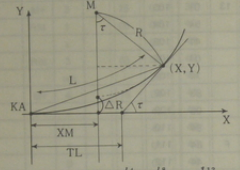
SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD
PROGRAM NO.
P2-C-13

TITLE **CLOTHOID CURVE**

[Formula]

This program calculates the various elements from the parameter (A) and radius (R).



$$L=\frac{A^2}{R} \qquad l=\frac{A}{R}$$

$$X \fallingdotseq A\left(1-\frac{l^4}{40}+\frac{l^8}{3456}-\frac{l^{12}}{599040}\right)$$

$$Y \fallingdotseq \frac{Al^3}{6}\left(1-\frac{l^4}{56}+\frac{l^8}{7040}-\frac{l^{12}}{1612800}\right)$$

$$\tau=\frac{L}{2R}\times\frac{180}{\pi}$$

reference;

$$\begin{cases} XM=X-R\sin\tau \\ TL=X-Y\cot\tau \\ \triangle R=Y+R\cos\tau-R \end{cases}$$

[Example]

$A=100$ $\quad X=49.922\text{m}$

$R=200\text{m}$ $\quad Y=2.080\text{m}$

$t=7°09'43''$

reference

$$\begin{cases} XM=24.9870 \\ TL=33.3607 \\ \triangle R=0.5205 \end{cases}$$

[Operation]

CA

(A) 100 S/E

(R) 200 S/E (X) 49.922

S/E (Y) 2.081

S/E (τ) 7.094310078⇨(7°9'48"10078)

STEP	KEY		KEY CODE	STEP	KEY		KEY CODE
0	F	CAM	F 45	32		×	54
1	x→M	0	55 00	33		=	84
2	F	HLT	F 12	34		=	84
3	x→M	1	55 01	35		÷	44
4	RM	0	65 00	36		5	05
5		÷	44	37		9	09
6	RM	1	65 01	38		9	09
7	M+	2	75 02	39		0	00
8		×	54	40		4	04
9	RM	0	65 00	41		0	00
10	M+	3	75 03	42		+/−	82
11	RM	2	65 02	43	M+	5	75 05
12	F	x^2	F 44	44	RM	5	65 05
13	F	x^3	F 44	45		×	54
14	x→M	4	55 04	46	RM	0	65 00
15		1	01	47		×	54
16	x→M	5	55 05	48	RM	2	65 02
17	RM	4	65 04	49		=	84
18		÷	44	50	x→M	5	55 05
19		4	04	51		1	01
20		0	00	52	x→M	6	55 06
21		+/−	82	53	RM	4	65 04
22	M+	5	75 05	54		÷	44
23	RM	4	65 04	55		5	05
24	F	x^2	F 44	56		6	06
25		÷	44	57		+/−	82
26		3	03	58	M+	6	75 06
27		4	04	59	RM	4	65 04
28		5	05	60	F	x^3	F 44
29		6	06	61		÷	44
30	M+	5	75 05	62		7	07
31	RM	4	65 04	63		0	00

MEMORY				LABEL			
s		4	ℓ^4	s		4	
t		5	X	t	√	5	
0	A	6	Y	0		6	
1	R	7	τ	1	TAB	7	
2	ℓ	8		2		8	
3	L	9		3		9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64		4		04	96		÷			44				
65		0		00	97	RM	1		65	01				
66	M+	6	75	06	98		÷			44				
67	RM	4	65	04	99	F	π		F	41				
68		×		54	100	M+	7		75	07				
69		=		84	101	GTO	t		14	83				
70		=		84	102	F LBL	t	F	13	83				
71		÷		44	103	RM	5		65	05				
72		1		01	104	F GTS	1	F	14	01				
73		6		06	105	RM	6		65	06				
74		1		01	106	F GTS	1	F	14	01				
75		2		02	107	RM	7		65	07				
76		8		08	108	F	D·MS		F	21				
77		0		00	109		S/E			85				
78		0		00	110	F LBL	1	F	13	01				
79		+/−		82	111		x			54				
80	M+	6	75	06	112		EXP			41				
81	RM	4	65	04	113		3			03				
82		÷		44	114		+			74				
83	RM	2	65	02	115		·			83				
84		×		54	116		5			05				
85	RM	6	65	06	117		=			84				
86		×		54	118	F	int		F	84				
87	RM	0	65	00	119		x			54				
88		÷		44	120		EXP			41				
89		6		06	121		3			03				
90		=		84	122		+/−			82				
91	x→M	6	55	06	123		=			84				
92	RM	3	65	03	124	F	HLT		F	12				
93		×		54	125		S/E			85				
94		9		09	126									
95		0		00	127									

NOTE

SHARP

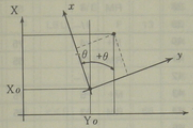
ANGLE DESIGNATION
(DEG) RAD GRAD

TITLE
COORDINATES CONVERSION

PROGRAM NO.
P2–C–14

[Formula]

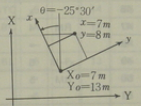
This program converts the coordinates.



$$X = X_o + x\cos\theta - y\sin\theta$$
$$Y = Y_o + x\sin\theta + y\cos\theta$$

$$x = (X - X_o)\cos\theta + (Y - Y_o)\sin\theta$$
$$y = (Y - Y_o)\cos\theta - (X - X_o)\sin\theta$$

[Example]



[Operation]

(X_o)	7	GTO 3 S/E	initial condition
(Y_o)	13	S/E	
(θ)	25.30	+/− S/E	
		CA	
(x)	7	S/E	
(y)	8	S/E (X)	16.762
		S/E (Y)	17.207

(reverse conversion)

(X)	16.762	GTO 2 S/E	
(Y)	17.207	S/E (x)	7
		S/E (y)	8

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		x→M	4	55 04	32	F	GTS	1	F 14 01
1		F	HLT	F 12 33				S/E	85
2		x→M	5	55 05	34	F	LBL	2	F 13 02
3		RM	1	65 01	35		x→M	4	55 04
4		x→M	6	55 06	36		F	HLT	F 12
5		RM	2	65 02	37		x→M	5	55 05
6		x→M	7	55 07	38		RM	1	65 01
7		RM	3	65 03	39			+/−	82
8			cos	23	40		M+	4	75 04
9			x	54	41		RM	2	65 02
10		RM	4	65 04	42			+/−	82
11			=	84	43		M+	5	75 05
12		M+	6	75 06	44		RM	3	65 03
13		RM	5	65 05	45			cos	23
14			=	84	46			x	54
15		M+	7	75 07	47		RM	4	65 04
16		RM	3	65 03	48			=	84
17			sin	22	49		x→M	6	55 06
18			x	54	50		RM	5	65 05
19		RM	4	65 04	51			=	84
20			=	84	52		x→M	7	55 07
21		M+	7	75 07	53		RM	3	65 03
22		RM	5	65 05	54			sin	22
23			+/−	82	55			x	54
24			=	84	56		RM	5	65 05
25		M+	6	75 06	57			=	84
26		GTO	t	14 83	58		M+	6	75 06
27	F	LBL	t	F 13 83	59		RM	4	65 04
28		RM	6	65 06	60			+/−	82
29	F	GTS	1	F 14 01	61			=	84
30		F	HLT	F 12	62		M+	7	75 07
31		RM	7	65 07	63		GTO	t	14 83

MEMORY				LABEL			
s		4	x, X	s		4	
t		5	y, Y	t	√	5	
0		6	X, x	0		6	
1	Xo	7	Y, y	1	TAB	7	
2	Yo	8		2	2 PRO	8	
3	θ	9		3	3 PRO	9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64	F	LBL	t	F 13 83	96			DEG	21
65		RM	6	65 06	97		x→M	3	55 03
66	F	GTS	1	F 14 01	98			S/E	85
67		F	HLT	F 12	99				
68		RM	7	65 07	100				
69	F	GTS	1	F 14 01	101				
70			S/E	85	102				
71	F	LBL	1	F 13 01	103				
72			x	54	104				
73			EXP	41	105				
74			3	03	106				
75			=	84	107				
76	F	$x<0$	4	F 65 04	108				
77			+	74	109				
78		GTO	5	14 05	110				
79	F	LBL	4	F 13 04	111				
80			−	64	112				
81	F	LBL	5	F 13 05	113				
82			•	83	114				
83			5	05	115				
84			=	84	116				
85		F	int	F 84	117				
86			÷	44	118				
87			EXP	41	119				
88			3	03	120				
89			=	84	121				
90			S/E	85	122				
91	F	LBL	3	F 13 03	123				
92		x→M	1	55 01	124				
93		F	HLT	F 12	125				
94		x→M	2	55 02	126				
95		F	HLT	F 12	127				

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE THE NUMBER OF REINFORCING RODS NEEDED

PROGRAM NO. P2-D-1

[Formula]

The number of steel needed in concrete is to be computed by calculated circle length & cross section of steel.

n: number of steel D: diameter (mm)

$$\psi = 2\pi\left(\frac{D}{2}\times\frac{1}{10}\right)\times n = \frac{\pi D}{10} n$$

$$a_t = \pi\left(\frac{D}{2}\times\frac{1}{10}\right)^2 \times n = \frac{\pi D^2}{400}\cdot n$$

adopt greater than

[Example]

When $\begin{cases}\psi = 27.55\text{cm} \\ a_t = 10.086\text{cm}^2, \text{solve the number of steel, using } D = 13\text{mm}\phi \text{ steel}\end{cases}$

[Operation]

Diameter should be stored by the second program.

(i) (D) 13 [GTO] [2] [S/E]

(ii) [CA]

(ψ) 27.55 [S/E]

(a_t) 10.086 [S/E] (n) 8

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE		
0		x→M	1	55	01	32			S/E			85
1		F	HLT	F	12	33	F	LBL	3	F	13	03
2		x→M	s	55	82	34			1			01
3		RM	0	65	00	35		M+	2		75	02
4		F	x^2	F	44	36		RM	2		65	02
5			x		54	37		F	int		F	84
6		F	π	F	41	38			S/E			85
7			÷		44	39	F	LBL	1	F	13	01
8			4		04	40		RM	t		65	83
9			0		00	41		F	frac		F	83
10			0		00	42	F	x≠0	4	F	55	04
11			÷		44	43		RM	t		65	83
12		RM	s	65	82	44		F	int		F	84
13			‡		45	45			S/E			85
14			=		84	46	F	LBL	4	F	13	04
15		x→M	t	55	83	47			1			01
16		RM	1	65	01	48		M+	t		75	83
17			x		54	49		RM	t		65	83
18			1		01	50		F	int		F	84
19			0		00	51			S/E			85
20			÷		44	52	F	LBL	2	F	13	02
21		F	π	F	41	53		x→M	0		55	00
22			÷		44	54			S/E			85
23		RM	0	65	00	55						
24			=		84	56						
25		x→M	2	55	02	57						
26	F	x<t	1	F 85	01	58						
27		RM	2	65	02	59						
28		F	frac	F	83	60						
29	F	x≠0	3	F 55	03	61						
30		RM	2	65	02	62						
31		F	int	F	84	63						

MEMORY

s	a_t	4	
t	n_2	5	
0	D	6	
1	ψ	7	
2	n_1	8	
3		9	

LABEL

s		4	√
t		5	
0		6	
1	√	7	
2	√	8	
3	√	9	

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **BEND MOMENT OF THE SLAB**

PROGRAM NO.
P2-D-2

[Formula]

$$w_x = w\frac{l_y^4}{l_x^4+l_y^4}$$

short span direction

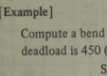
end $Mx_1=-\frac{1}{12}w_x l_x^2$ center $Mx_2=\frac{1}{18}w_x l_x^2$

long span direction

end $My_1=-\frac{1}{24}w l_x^2$ center $My_2=\frac{1}{36}w l_x^2$

[Example]

Compute a bend moment of the slab when liveload is 180 (Kg/m²), deadload is 450 (Kg/m²)



Solution $lx=4.0-0.3=3.7[m]$ lx_1 span length

$ly=6.0-0.3=5.7[m]$ ly_1

$w=180+450=630[kg/m^2]$ lx_2 girder width

ly_2

$w_x=630\frac{5.7^4}{3.7^4+5.7^4}=535[kg/m^2]$ w_1 live load w_2 dead load

$Mx_1=-\frac{1}{12}\times535\times3.7^2=-610[kg/m]$

$Mx_2=\frac{1}{18}\times535\times3.7^2=407[kg/m]$

$My_1=-\frac{1}{24}\times630\times3.7^2=-359[kg/m]$

$My_2=\frac{1}{36}\times630\times3.7^2=240[kg/m]$

[Operation]

		CA
(lx_1)	4m	S/E
(ly_1)	6m	S/E
(lx_2)	30cm	S/E
(ly_2)	30cm	S/E
(w_1)	180kg/m²	S/E
(w_2)	450kg/m²	S/E (Mx_1) −610.3590459
		S/E (Mx_2) 406.9060306
		S/E (My_3) −359.3625
		S/E (My_4) 239.575

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	t	55	83	32		y^x		31
1	F	HLT	F	12	33		4		04
2	x→M	s	55	82	34		=		84
3	F	HLT	F	12	35	M+	6	75	06
4	x→M	0	55	00	36		÷		44
5	F	HLT	F	12	37	RM	6	65	06
6	x→M	1	55	01	38		x		54
7	F	HLT	F	12	39		(		42
8	x→M	2	55	02	40	RM	2	65	02
9	F	HLT	F	12	41		+		74
10	x→M	3	55	03	42	RM	3	65	03
11	RM	0	65	00	43		)		43
12		÷		44	44		=		84
13		1		01	45	x→M	7	55	07
14		0		00	46	RM	t	65	83
15		0		00	47	F	x^2	F	44
16		=		84	48		x		54
17	x→M	4	55	04	49	RM	7	65	07
18	RM	1	65	01	50		÷		44
19		=		84	51		1		01
20	x→M	5	55	05	52		2		02
21		+/−		82	53		=		84
22	M+	s	75	82	54		+/−		82
23	RM	4	65	04	55	F	HLT	F	12
24		+/−		82	56	RM	t	65	83
25	M+	t	75	83	57	F	x^3	F	44
26	RM	t	65	83	58		x		54
27		y^x		31	59	RM	7	65	07
28		4		04	60		÷		44
29		=		84	61		1		01
30	x→M	6	55	06	62		8		08
31	RM	s	65	82	63		=		84

MEMORY				LABEL			
s	ϱy_1, ϱy	4	$\varrho x_2/100$	s		4	
t	ϱx_1, ϱx	5	$\varrho y_2/100$	t		5	
0	ϱx_3	6	$\sqrt{}$	0		6	
1	ϱy_3	7	wx	1		7	
2	w_1	8		2		8	
3	w_2	9		3		9	

STEP	KEY		KEY CODE		STEP	KEY	KEY CODE
64	F	HLT	F	12	96		
65	RM	t	65	83	97		
66	F	x^2	F	44	98		
67		x		54	99		
68		(		42	100		
69	RM	2	65	02	101		
70		+		74	102		
71	RM	3	65	03	103		
72		)		43	104		
73		÷		44	105		
74		2		02	106		
75		4		04	107		
76		=		84	108		
77		+/−		82	109		
78	F	HLT	F	12	110		
79	RM	t	65	83	111		
80	F	x^2	F	44	112		
81		x		54	113		
82		(		42	114		
83	RM	2	65	02	115		
84		+		74	116		
85	RM	3	65	03	117		
86		)		43	118		
87		÷		44	119		
88		3		03	120		
89		6		06	121		
90		=		84	122		
91		S/E		85	123		
92					124		
93					125		
94					126		
95					127		

NOTE

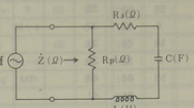
SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD

TITLE
SERIES RESONANT CIRCUIT

PROGRAM NO.
P2−E−1

[Formula]



$$\dot{Z}=R_p\cdot\frac{(1-\omega^2LC)+jR_s\omega C}{(1-\omega^2LC)+j\ (R_s+R_p)\ \omega C}\quad[\Omega]$$

$$=x+jy\quad[\Omega]$$

[Example]

$$\begin{cases}C=5\ [\mu F]\\ L=30\ [mH]\\ R_s=6\ [\Omega]\\ R_p=15\ [\Omega]\\ f=60\ [Hz]\end{cases}\quad\text{solution}\quad\begin{cases}x=14.98\\ y=4.326\\ \therefore\dot{Z}=14.98-4.326j\ [\Omega]\end{cases}$$

[Operation]

CA

(C) 5×10^{-6} S/E

(L) 30×10^{-3} S/E

(R_s) 6 S/E

(R_p) 15 S/E

(f) 60 S/E (x) 14.98250108

S/E (y) $-4.326456183\times10^{-1}$

STEP	KEY	KEY CODE	STEP	KEY	KEY CODE
0	x→M 0	55 00	32	=	84
1	F HLT	F 12	33	↕	45
2	x→M 1	55 01	34	RM 5	65 05
3	F HLT	F 12	35	↕	45
4	x→M 2	55 02	36	F →rθ	F 64
5	F HLT	F 12	37	x→M 6	55 06
6	x→M 3	55 03	38	↕	45
7	F HLT	F 12	39	x→M 7	55 07
8	x→M 4	55 04	40	RM 2	65 02
9	x	54	41	+	74
10	2	02	42	RM 3	65 03
11	x	54	43	x	54
12	F π	F 41	44	RM 0	65 00
13	=	84	45	=	84
14	x→M 4	55 04	46	↕	45
15	F x^2	F 44	47	RM 5	65 05
16	x	54	48	↕	45
17	RM 0	65 00	49	F →rθ	F 64
18	x	54	50	↕	45
19	RM 1	65 01	51	+/−	82
20	−	64	52	M+ 7	75 07
21	1	01	53	↕	45
22	=	84	54	÷	44
23	+/−	82	55	RM 6	65 06
24	x→M 5	55 05	56	↕	45
25	RM 4	65 04	57	=	84
26	x	54	58	↕	45
27	RM 0	65 00	59	RM 7	65 07
28	=	84	60	F →xy	F 74
29	x→M 0	55 00	61	↕	45
30	x	54	62	x→M 7	55 07
31	RM 2	65 02	63	↕	45

MEMORY

s		4	f→2πf
t		5	$1-\omega^2 LC$
0	C→ωC	6	R_1/R_2
1	L	7	$\theta_1-\theta_2$
2	Rs	8	
3	Rp	9	

LABEL

s	4
t	5
0	6
1	7
2	8
3	9

STEP	KEY	KEY CODE	STEP	KEY	KEY CODE
64	x	54	96		
65	RM 3	65 03	97		
66	=	84	98		
67	F HLT	F 12	99		
68	RM 7	65 07	100		
69	x	54	101		
70	RM 3	65 03	102		
71	=	84	103		
72	S/E	85	104		
73			105		
74			106		
75			107		
76			108		
77			109		
78			110		
79			111		
80			112		
81			113		
82			114		
83			115		
84			116		
85			117		
86			118		
87			119		
88			120		
89			121		
90			122		
91			123		
92			124		
93			125		
94			126		
95			127		

NOTE

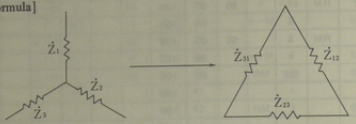
SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD

TITLE Y → △ TRANSLATION

PROGRAM NO.
P2-E-2

[Formula]



$$\dot{Z}_{12}=\frac{\Delta}{\dot{Z}_3}\ (\Omega),\quad \dot{Z}_{23}=\frac{\Delta}{\dot{Z}_2}\ (\Omega),\quad \dot{Z}_{31}=\frac{\Delta}{\dot{Z}_1}\ (\Omega)$$

$$\Delta=\dot{Z}_1\dot{Z}_2+\dot{Z}_2\dot{Z}_3+\dot{Z}_3\dot{Z}_1$$

$$\begin{cases}\dot{Z}_1=x_1+y_1\mathrm{j}\ (\Omega)\\ \dot{Z}_2=x_2+y_2\mathrm{j}\ (\Omega)\\ \dot{Z}_3=x_3+y_3\mathrm{j}\ (\Omega)\end{cases}$$

[Example]

$$\begin{cases}x_1=\ 8\\ y_1=\ 3\\ x_2=\ 9\\ y_2=-5\\ x_3=\ 7\\ y_3=\ 6\end{cases}$$

solution

$$\begin{cases}\dot{Z}_{12}=23.25-9.21\mathrm{j}\ (\Omega)\\ \dot{Z}_{23}=26.97-0.74\mathrm{j}\ (\Omega)\\ \dot{Z}_{31}=14.97+16.65\mathrm{j}\ (\Omega)\end{cases}$$

SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD

TITLE Y → △ TRANSLATION

PROGRAM NO.
P2-E-2

[Operation]

	CA	
(x_1)	8 S/E	
(y_1)	3 S/E	
(x_2)	9 S/E	
(y_2)	−5 S/E	
(x_3)	7 S/E	
(y_3)	6 S/E	($\dot{Z}_{12}$ real part) 23.24705882
	S/E	($\dot{Z}_{12}$ imaginary part) −9.211764705
	S/E	($\dot{Z}_{23}$ real part) 26.97260273
	S/E	($\dot{Z}_{23}$ imaginary part) $-7.397260277\times10^{-1}$
	S/E	($\dot{Z}_{31}$ real part) 14.97169811
	S/E	($\dot{Z}_{31}$ imaginary part) 16.65094339

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		x→M	0	55 00	32		M+	t	75 83
1		F	HLT	F 12	33		RM	4	65 04
2		x→M	1	55 01	34			↕	45
3		F	HLT	F 12	35		RM	5	65 05
4		x→M	2	55 02	36	F	GTS	1	F 14 01
5		F	HLT	F 12	37		RM	0	65 00
6		x→M	3	55 03	38			↕	45
7		F	HLT	F 12	39		RM	1	65 01
8		x→M	4	55 04	40	F	GTS	2	F 14 02
9		F	HLT	F 12	41		M+	9	75 09
10		x→M	5	55 05	42			↕	45
11		RM	0	65 00	43		M+	t	75 83
12			↕	45	44		RM	9	65 09
13		RM	1	65 01	45			↕	45
14	F	GTS	1	F 14 01	46		RM	t	65 83
15		RM	2	65 02	47	F	GTS	1	F 14 01
16			↕	45	48		RM	4	65 04
17		RM	3	65 03	49			↕	45
18	F	GTS	2	F 14 02	50		RM	5	65 05
19		x→M	9	55 09	51	F	GTS	3	F 14 03
20			↕	45	52		F	HLT	F 12
21		x→M	t	55 83	53			↕	45
22		RM	2	65 02	54		F	HLT	F 12
23			↕	45	55		RM	9	65 09
24		RM	3	65 03	56			↕	45
25	F	GTS	1	F 14 01	57		RM	t	65 83
26		RM	4	65 04	58	F	GTS	1	F 14 01
27			↕	45	59		RM	0	65 00
28		RM	5	65 05	60			↕	45
29	F	GTS	2	F 14 02	61		RM	1	65 01
30		M+	9	75 09	62	F	GTS	3	F 14 03
31			↕	45	63		F	HLT	F 12

MEMORY

s		4	R(Z_1)
t	J(Δ)	5	J(Z_3)
0	R(Z_1)	6	
1	J(Z_1)	7	√
2	R(Z_2)	8	√
3	J(Z_2)	9	R(Δ)

LABEL

s		4	
t		5	
0		6	
1	√	7	
2	√	8	
3	√	9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64			↕	45	96		F	→rθ	F 64
65		F	HLT	F 12	97			↕	45
66		RM	9	65 09	98			+/–	82
67			↕	45	99		M+	8	75 08
68		RM	t	65 83	100			↕	45
69	F	GTS	1	F 14 01	101			÷	44
70		RM	2	65 02	102		RM	7	65 07
71			↕	45	103			↕	45
72		RM	3	65 03	104			=	84
73	F	GTS	3	F 14 03	105			↕	45
74		F	HLT	F 12	106		RM	8	65 08
75			↕	45	107		F	→xy	F 74
76			S/E	85	108			S/E	85
77	F	LBL	1	F 13 01	109				
78		F	→rθ	F 64	110				
79		x→M	7	55 07	111				
80			↕	45	112				
81		x→M	8	55 08	113				
82			S/E	85	114				
83	F	LBL	2	F 13 02	115				
84		F	→rθ	F 64	116				
85			↕	45	117				
86		M+	8	75 08	118				
87			↕	45	119				
88			x	54	120				
89		RM	7	65 07	121				
90			=	84	122				
91			↕	45	123				
92		RM	8	65 08	124				
93		F	→xy	F 74	125				
94			S/E	85	126				
95	F	LBL	3	F 13 03	127				

NOTE

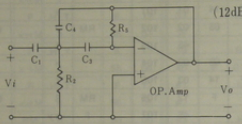
SHARP

ANGLE DESIGNATION: (DEG) RAD GRAD

TITLE: HIGH – PASS ACTIVE FILTER

PROGRAM NO.: P2-E-3

[Formula]



(12dB/Oct)

$$R_2=\frac{\alpha}{2\pi f_c C_1\left(2+\frac{1}{G'}\right)} \quad [\Omega]$$

$$R_3=\frac{2G'+1}{\alpha\, 2\pi f_c C_1} \quad [\Omega]$$

$$G=20\log G' \quad [dB]$$

$$C_3=C_1 \quad [F]$$

$$C_4=\frac{C_1}{G'} \quad [F]$$

$$\begin{cases} G'=\dfrac{V_o}{V_i} & \text{(far higher than } f_c\text{)} \\ \alpha=2\xi & (0\leq\alpha\leq 2) \\ f_c: \text{ cut off frequency} \end{cases}$$

SHARP

ANGLE DESIGNATION: (DEG) RAD GRAD

TITLE: HIGH – PASS ACTIVE FILTER

PROGRAM NO.: P2-E-3

[Example]

$$\begin{cases} G=20\ [dB] \\ f_c=20\ [Hz] \\ \alpha=1 \\ C_1=C_3=0.5\ [\mu F] \end{cases} \quad \text{Solution} \quad \begin{cases} R_2=7578.81\ [\Omega] \\ R_3=334225.38\ [\Omega] \\ C_4=0.5\times10^{-7}\ [F] \end{cases}$$

[Operation]

	CA
(G) 20	S/E
(f_c) 20	S/E
(α) 1	S/E
(C_1) 0.5×10^{-6}	S/E (R_2) 7578.806817
	S/E (R_3) 334225.3806
	S/E (C_4) 0.00000005

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		÷		44	32		=		84
1		2		02	33	F	HLT	F	12
2		0		00	34		2		02
3		=		84	35		x		54
4	F	10^x	F	32	36	RM	0	65	00
5	x→M	0	55	00	37		+		74
6	F	HLT	F	12	38		1		01
7		x		54	39		÷		44
8		2		02	40	RM	4	65	04
9		x		54	41		÷		44
10	F	π	F	41	42	RM	3	65	03
11		=		84	43		÷		44
12	x→M	3	55	03	44	RM	1	65	01
13	F	HLT	F	12	45		=		84
14	x→M	4	55	04	46	F	HLT	F	12
15	F	HLT	F	12	47	RM	1	65	01
16	x→M	1	55	01	48		÷		44
17	x→M	2	55	02	49	RM	0	65	00
18	RM	3	65	03	50		=		84
19		x		54	51		S/E		85
20	RM	1	65	01	52				
21		x		54	53				
22		(		42	54				
23		2		02	55				
24		+		74	56				
25	RM	0	65	00	57				
26	F	1/x	F	43	58				
27		)		43	59				
28		=		84	60				
29	F	1/x	F	43	61				
30		x		54	62				
31	RM	4	65	04	63				

MEMORY				LABEL			
s		4	α	s		4	
t		5		t		5	
0	G'	6		0		6	
1	C_1	7		1		7	
2	C_2	8		2		8	
3	2πfc	9		3		9	

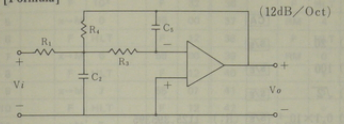
SHARP

ANGLE DESIGNATION: DEG RAD GRAD

TITLE: **LOW – PASS ACTIVE FILTER**

PROGRAM NO.: P2–E–4

[Formula]



$$R_4=\frac{\alpha}{4\pi f_c C_5}\ [\Omega]$$

$$R_1=\frac{R_4}{G'}\ [\Omega]$$

$$R_3=\frac{R_4}{G'+1}\ [\Omega]$$

$$C_2=\frac{G'+1}{R_4\alpha\pi f_c}\ [F]$$

$G = 20\log G'$ (G: target)

$G'=\frac{V_o}{V_i}$ (far lower than f_c)

$\alpha = 2\xi$ $(0 \le \alpha \le 2)$

f_c : cut off frequency

[Example]

$G = 20$ [dB]
$f_c = 100$ [Hz]
$\alpha = \sqrt{2}$
$C_5 = 0.1$ [μF]

solution

$R_1 = 1125.4$ [Ω]
$R_3 = 1023.1$ [Ω]
$R_4 = 11.254$ [kΩ]
$C_2 = 2.2$ [μF]

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE LOW – PASS ACTIVE FILTER

PROGRAM NO. P2–E–4

[Operation]

CA

(G) 20 S/E

(f_c) 100 S/E

(α) $\sqrt{2}$ S/E

(C_3) 0.1×10^{-6} S/E (R_1) 1125.395395

S/E (R_3) 1023.086723

S/E (R_4) 11253.95395

S/E (C_2) 2.2×10^{-6}

STEP	KEY		KEY CODE	STEP	KEY		KEY CODE
0		÷	44	32		+	74
1		2	02	33		1	01
2		0	00	34		)	43
3		=	84	35		=	84
4	F	10^x	F 32	36	F	HLT	F 12
5	x→M	0	55 00	37	RM	4	65 04
6	F	HLT	F 12	38	F	HLT	F 12
7	x→M	6	55 06	39	RM	0	65 00
8	F	HLT	F 12	40		+	74
9	x→M	7	55 07	41		1	01
10	F	HLT	F 12	42		÷	44
11	x→M	5	55 05	43	RM	4	65 04
12		x	54	44		÷	44
13	RM	6	65 06	45	RM	7	65 07
14		x	54	46		÷	44
15		4	04	47	F	π	F 41
16		x	54	48		÷	44
17	F	π	F 41	49	RM	6	65 06
18		=	84	50		=	84
19	F	1/x	F 43	51		S/E	85
20		x	54	52			
21	RM	7	65 07	53			
22		=	84	54			
23	x→M	4	55 04	55			
24		÷	44	56			
25	RM	0	65 00	57			
26		=	84	58			
27	F	HLT	F 12	59			
28	RM	4	65 04	60			
29		÷	44	61			
30		(	42	62			
31	RM	0	65 00	63			

MEMORY				LABEL			
s		4	R_4	s		4	
t		5	C_3	t		5	
0	G'	6	fc	0		6	
1	R_1	7	α	1		7	
2	C_2	8		2		8	
3	R_3	9		3		9	

[Formula]

Square

$$A_i = \Delta x \cdot Y_{n-1}$$

$$X_i = (\frac{1}{2}\Delta x + X_{n-1})A_i$$

$$Y_i = \frac{1}{2} \cdot Y_{n-1} \cdot A_i$$

Triangle

$$A_i = \frac{1}{2}\Delta x \cdot \Delta y$$

$$X_i = (\frac{2}{3}\Delta x + X_{n-1})A_i$$

$$Y_i = (\frac{1}{3}\Delta y + Y_{n-1})A_i$$

$\sum A_i$: Section (m^2)

$\gamma \sum A_i$: Weight (t/m^2)

$X_G = \frac{\sum X_i}{\sum A_i}$: Centroid (m)

$Y_G = \frac{\sum Y_i}{\sum A_i}$: Centroid (m)

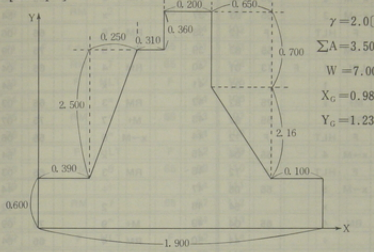
SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE SECTION, DEAD LOAD AND CENTROID OF A POLYGON

PROGRAM NO.
P2-F-1

[Example]



$\gamma = 2.0 [t/m^2]$
$\sum A = 3.501 (m^2)$
$W = 7.003 (t)$
$X_G = 0.980 (m)$
$Y_G = 1.231 (m)$

[Operation]

	CA
(X_0) 0	S/E
(Y_0) 0	S/E
(γ) 2	S/E
(ΔX_1) 0	S/E
(ΔY_1) 0.6	S/E
(ΔX_2) 0.39	S/E
(ΔY_2) 0	S/E
⋮	⋮
(ΔX_n) 1.9	+/− S/E
(ΔY_n) 0	S/E (A) 3.5015
	S/E (W) 7.003
	S/E (X_G) $9.804607549 \times 10^{-1}$
	S/E (Y_G) 1.231319911

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	F	CAM	F	45	32	RM	5	65	05
1	x→M	0	55	00	33	÷			44
2	x→M	1	55	01	34	3			03
3	F	HLT	F	12	35	+			74
4	x→M	2	55	02	36	RM	3	65	03
5	x→M	3	55	03	37	x			54
6	F	HLT	F	12	38	RM	6	65	06
7	x→M	t	55	83	39	M+	9	75	09
8	F LBL	1	F 13	01	40	RM	4	65	04
9		1		01	41	x			54
10	M+	s	75	82	42	RM	3	65	03
11	RM	s	65	82	43	M+	7	75	07
12	F	HLT	F	12	44	x→M	6	55	06
13	x→M	4	55	04	45	x			54
14	F	HLT	F	12	46	RM	3	65	03
15	x→M	5	55	05	47	÷			44
16		x		54	48	2			02
17	RM	4	65	04	49	M+	9	75	09
18		÷		44	50	RM	4	65	04
19		2		02	51	÷			44
20	M+	7	75	07	52	2			02
21	x→M	6	55	06	53	+			74
22	RM	4	65	04	54	RM	1	65	01
23		÷		44	55	x			54
24		1		01	56	RM	6	65	06
25		·		83	57	M+	8	75	08
26		5		05	58	RM	4	65	04
27		+		74	59	M+	1	75	01
28	RM	1	65	01	60	RM	5	65	05
29		x		54	61	M+	3	75	03
30	RM	6	65	06	62	RM	1	65	01
31	M+	8	75	08	63		−		64

MEMORY

s		4	ΔXi
t	γ	5	ΔYi
0	X_0	6	Ai
1	$X_0 \sim Xn$	7	ΣAi
2	X_0	8	ΣXi
3	$Y_0, \sim Yn$	9	ΣYi

LABEL

s		4	
t		5	
0		6	
1	√	7	
2		8	
3		9	

STEP	KEY		KEY CODE		STEP	KEY	KEY CODE
64	RM	0	65	00	96		
65		=		84	97		
66	F $x \neq 0$	1	F 55	01	98		
67	RM	3	65	03	99		
68		−		64	100		
69	RM	2	65	02	101		
70		=		84	102		
71	F $x \neq 0$	1	F 55	01	103		
72	RM	7	65	07	104		
73	F	HLT	F	12	105		
74		x		54	106		
75	RM	t	65	83	107		
76		=		84	108		
77	F	HLT	F	12	109		
78	RM	8	65	08	110		
79		÷		44	111		
80	RM	7	65	07	112		
81		=		84	113		
82	F	HLT	F	12	114		
83	RM	9	65	09	115		
84		÷		44	116		
85	RM	7	65	07	117		
86		=		84	118		
87	F	HLT	F	12	119		
88		S/E		85	120		
89					121		
90					122		
91					123		
92					124		
93					125		
94					126		
95					127		

NOTE

SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD

TITLE **COULOMB'S EARTH – PRESSURE**

PROGRAM NO. P2-F-2

[Formula]

Seismic case

$$K_{EA} = \frac{\cos^2(\phi-\theta_o-\theta)}{\cos\theta_o \cos^2\theta \cos(\theta+\theta_o+\delta)\left\{1+\sqrt{\frac{\sin(\phi+\delta)\cdot\sin(\phi-\alpha-\theta_o)}{\cos(\theta+\theta_o+\delta)\cdot\cos(\theta-\alpha)}}\right\}^2}$$

Permanent case

$K_A = K_{EA}(\theta_o = 0)$

α : Angle closed by earth surface and level surface

ϕ : Internal friction angle of back-filling soil

θ : Angle closed by wall back surface and horizontal surface

δ : Angle closed by wall back surface normal line and earth pressure active direction

[Example]

$\phi = 35°$

$\theta = 21°48'$

$\theta_o = 11°19'$

$\delta = 0$

$K_A = 0.4348$

$K_{EA} = 0.5858$

$\alpha = 0$

[Operation] CA

(ϕ) 35 S/E

(α) 0 S/E

(θ) 21.48 S/E

(θ_o) 11.19 S/E

(δ) 0 S/E (K_{EA} or K_A) 5.858860166×10^{-1}

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	0	55	00	32	RM	4	65	04
1	F	HLT	F	12	33		=		84
2	x→M	1	55	01	34		cos		23
3	F	HLT	F	12	35	x→M	7	55	07
4	x→M	2	55	02	36		x		54
5	F	HLT	F	12	37	RM	t	65	83
6	x→M	3	55	03	38		=		84
7	F	HLT	F	12	39	x→M	t	55	83
8	x→M	4	55	04	40	RM	0	65	00
9	RM	0	65	00	41		+		74
10		–		64	42	RM	4	65	04
11	RM	3	65	03	43		=		84
12		–		64	44		sin		22
13	RM	2	65	02	45	x→M	5	55	05
14		=		84	46	RM	0	65	00
15		cos		23	47		–		64
16	F	x^2	F	44	48	RM	1	65	01
17	x→M	s	55	82	49		–		64
18	RM	3	65	03	50	RM	3	65	03
19		cos		23	51		=		84
20	x→M	t	55	83	52		sin		22
21	RM	2	65	02	53		x		54
22		cos		23	54	RM	5	65	05
23	F	x^2	F	44	55		=		84
24		x		54	56	x→M	5	55	05
25	RM	t	65	83	57	RM	2	65	02
26		=		84	58		–		64
27	x→M	t	55	83	59	RM	1	65	01
28	RM	2	65	02	60		=		84
29		+		74	61		cos		23
30	RM	3	65	03	62		x		54
31		+		74	63	RM	7	65	07

MEMORY					LABEL				
s		4	8		s			4	
t		5			t	√		5	
0	ϕ	6			0			6	
1	α	7			1			7	
2	θ	8			2			8	
3	θ_o	9			3			9	

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64			÷			44	96						
65		RM	5		65	05	97						
66			‡			45	98						
67			=			84	99						
68		F	$\sqrt{}$		F	42	100						
69			+			74	101						
70			1			01	102						
71			=			84	103						
72		F	x^2		F	44	104						
73			x			54	105						
74		RM	t		65	83	106						
75			÷			44	107						
76		RM	s		65	82	108						
77			‡			45	109						
78			=			84	110						
79		GTO	t		14	83	111						
80	F	LBL	t	F	13	83	112						
81		F	HLT		F	12	113						
82			S/E			85	114						
83							115						
84							116						
85							117						
86							118						
87							119						
88							120						
89							121						
90							122						
91							123						
92							124						
93							125						
94							126						
95							127						

NOTE

SHARP

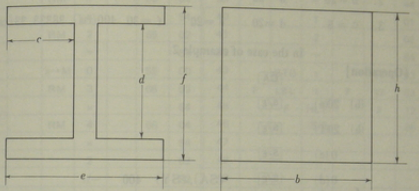
ANGLE DESIGNATION
DEG RAD GRAD

TITLE SECOND ORDER MOMENT OF SECTION

PROGRAM NO.
P2–F–3

[Formula]

This program calculates the second order moment of the following figures' sections.



H–form section

Rectangular form section

(1) Rectangular

$SA = b \cdot h$ SA : Area (cm²)

$SI = \frac{b \cdot h^3}{12}$ SI : Second order moment (cm⁴)

(2) H–form

$SY = e \cdot f - 2 \cdot Cd$ SY : Area (cm²)

$SZ = \frac{e \cdot f^3 - 2 \cdot cd^3}{12}$ SZ : Second order moment (cm⁴)

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE SECOND ORDER MOMENT OF SECTION

PROGRAM NO.
P2–F–3

[Example]

1. b =25 h =16 400(cm) 8533.33(cm⁴)
2. b =20 h =20 400(cm) 13333.33(cm⁴)
3. c = 5 d =20 e =20 f =30 400(cm) 38333.33(cm⁴)

In the case of example 2.

[Operation]

CA

(b) 20(e) S/E

(h) 20(f) S/E

0(c) S/E

0(d) S/E (SA), (SY) 400

S/E (SI), (SZ) 13333.3333

H–form

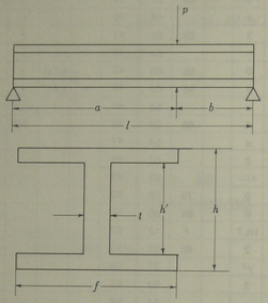
Rectangular form

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	1	55	01	32		x		54
1	F	HLT	F	12	33	RM	3	65	03
2	x→M	2	55	02	34		x		54
3	F	HLT	F	12	35		2		02
4	x→M	3	55	03	36		+/–		82
5	F	HLT	F	12	37	M+	0	75	00
6	x→M	4	55	04	38	RM	0	65	00
7	RM	1	65	01	39		÷		44
8		x		54	40		1		01
9	RM	2	65	02	41		2		02
10		=		84	42		=		84
11	x→M	0	55	00	43	GTO	t	14	83
12	RM	3	65	03	44	F LBL	t	F 13	83
13		x		54	45	F	HLT	F	12
14	RM	4	65	04	46		S/E		85
15		x		54	47				
16		2		02	48				
17		+/–		82	49				
18	M+	0	75	00	50				
19	RM	0	65	00	51				
20	F	HLT	F	12	52				
21	RM	2	65	02	53				
22		y^x		31	54				
23		3		03	55				
24		x		54	56				
25	RM	1	65	01	57				
26		=		84	58				
27	x→M	0	55	00	59				
28	RM	4	65	04	60				
29	F	x^2	F	44	61				
30		x		54	62				
31	RM	4	65	04	63				

MEMORY				LABEL			
s		4	d	s		4	
t		5		t	√	5	
0		6		0		6	
1	b e	7		1		7	
2	h f	8		2		8	
3	c	9		3		9	

[Formula]

When the concentrate load P operates the span of the girder as a following figure.



Reaction force

$$R_A = \frac{P \cdot b}{l} \quad , \quad R_B = \frac{P \cdot a}{l}$$

Bend moment

$$M_X = Ra \cdot a$$

Section coefficient

$$W = f \cdot h^3 - h'^3 \cdot (f - t) / 6h$$

Stress

$$\delta = \frac{M_X}{W}$$

[Example]

f =40(cm)

t =1.8(cm)

h =40(cm)

h'=36.4(cm)

p =13000(kg/cm)

l =10000(cm)

a =5000(cm)

b =5000(cm)

[Operation]

		CA		
(f)	40	S/E		
(t)	1.8	S/E		
(h)	40	S/E		
(h')	36.4	S/E		
(p)	13000	S/E		
(l)	10000	S/E		
(a)	5000	S/E		
(b)	5000	S/E	(R_A)	6500
		S/E	(R_B)	6500
		S/E	(M_X)	32500000
		S/E	(δ)	12.73349496

Repeat

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		x→M 0	55	00	32		=		84
1		F HLT	F	12	33		x→M 9	55	09
2		x→M 1	55	01	34		F HLT	F	12
3		F HLT	F	12	35		RM 3	65	03
4		x→M 2	55	02	36		y^x		31
5		F HLT	F	12	37		3		03
6		x→M 3	55	03	38		=		84
7	F	LBL 0	F	13 00	39		x→M s	55	82
8		F HLT	F	12	40		RM 0	65	00
9		x→M 4	55	04	41		−		64
10		F HLT	F	12	42		RM 1	65	01
11		x→M 5	55	05	43		×		54
12		F HLT	F	12	44		RM s	65	82
13		x→M 6	55	06	45		÷		44
14		F HLT	F	12	46		6		06
15		x→M 7	55	07	47		÷		44
16		RM 4	65	04	48		RM 2	65	02
17		÷		44	49		=		84
18		RM 5	65	05	50		x→M s	55	82
19		×		54	51		RM 2	65	02
20		RM 7	65	07	52		y^x		31
21		=		84	53		3		03
22		x→M 8	55	08	54		×		54
23		F HLT	F	12	55		RM 0	65	00
24		‡		45	56		−		64
25		×		54	57		RM s	65	82
26		RM 6	65	06	58		=		84
27		=		84	59		x→M t	55	83
28		F HLT	F	12	60		RM 9	65	09
29		RM 8	65	08	61		÷		44
30		×		54	62		RM t	65	83
31		RM 6	65	06	63		=		84

MEMORY

s		4	p
t	W	5	ℓ
0	f	6	a
1	t	7	b
2	h	8	R_A
3	h′	9	M_x

LABEL

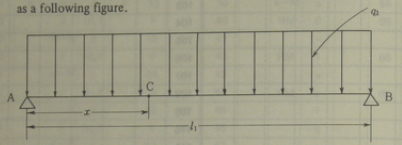
s		4	
t		5	
0	√	6	
1		7	
2		8	
3		9	

STEP	KEY		KEY CODE		STEP	KEY	KEY CODE
64		GTO t	14	83	96		
65	F	LBL t	F	13 83	97		
66		F HLT	F	12	98		
67		GTO 0	14	00	99		
68		S/E		85	100		
69					101		
70					102		
71					103		
72					104		
73					105		
74					106		
75					107		
76					108		
77					109		
78					110		
79					111		
80					112		
81					113		
82					114		
83					115		
84					116		
85					117		
86					118		
87					119		
88					120		
89					121		
90					122		
91					123		
92					124		
93					125		
94					126		
95					127		

NOTE

[Formula]

This program calculates a reaction force, a shearing force, a bend moment and a maximum bend moment of the simple girder with the uniform load, as a following figure.



Total load

$$W = q_1 l_1$$

Reaction force

$$R_{A1} = R_{A2} = \frac{W}{2}$$

Maximum bend moment

$$M_{MAX} = \frac{q_1 \cdot l_1^2}{8}$$

The shearing force (Sc) and the bend moment (Mc) of the point of C are shown.

$$Sc = q_1 \left(\frac{l_1}{2} - x \right)$$

$$Mc = q_1 \, x (l_1 - x) / 2$$

[Example]

$l_1 = 15$ (m)

$q_1 = 3$ (t/m)

$x = 2, 4, 8, 12$ (m)

[Operation]

		CA	
(q_1)	3	S/E	
(l_1)	15	S/E	(W) 45
		S/E	(R_{A1}) 22.5
		S/E	(M_{AX1}) 84.375
↱ (x)	2	S/E	(Sc) 16.5
		S/E	(Mc) 39
Repeat		S/E	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x↔M	1	55	01	32		−		64
1	F	HLT	F	12	33	RM	3	65	03
2	x↔M	2	55	02	34		×		54
3	RM	1	65	01	35	RM	3	65	03
4		×		54	36		×		54
5	RM	2	65	02	37	RM	1	65	01
6		=		84	38		÷		44
7	F	HLT	F	12	39		2		02
8		÷		44	40		=		84
9		2		02	41	GTO	t	14	83
10		=		84	42	F LBL	t	F 13	83
11	F	HLT	F	12	43	F	HLT	F	12
12	RM	2	65	02	44	GTO	s	14	82
13	F	x^2	F	44	45		S/E		85
14		×		54	46				
15	RM	1	65	01	47				
16		÷		44	48				
17		8		08	49				
18		=		84	50				
19	F LBL	s	F 13	82	51				
20	F	HLT	F	12	52				
21	x→M	3	55	03	53				
22	RM	2	65	02	54				
23		÷		44	55				
24		2		02	56				
25		−		64	57				
26	RM	3	65	03	58				
27		×		54	59				
28	RM	1	65	01	60				
29		=		84	61				
30	F	HLT	F	12	62				
31	RM	2	65	02	63				

MEMORY				LABEL			
s		4		s		4	
t		5		t	√	5	
0		6		0		6	
1	q_1	7		1		7	
2	ℓ_1	8		2		8	
3	x	9		3		9	

SHARP

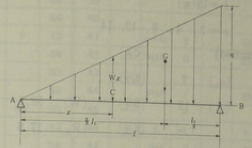
ANGLE DESIGNATION
DEG RAD GRAD

TITLE SECTIONAL FORCE OF SIMPLE GIRDER

PROGRAM NO. P2-F-6

[Formula]

This program calculates the sectional force of the simple girder with a load, as a following figure.



Total load

$$W=\frac{1}{2}q\cdot l$$

Reaction force

$$R_A=\frac{W}{3} \qquad R_B=\frac{2}{3}W$$

Maximum bend moment

$$M_{MAX}=\frac{q\cdot l^2}{9\sqrt{3}} \qquad x=\frac{l}{\sqrt{3}}$$

The shearing force (Sc) and the bend moment (Mc) of the point of C are shown.

$$wx=\frac{qx}{l}$$

Total load in the left side of the point of C

$$Wx=wx\cdot\frac{x}{2}$$

$$Sc=R_A-Wx$$

$$Mc=R_A\cdot x-Wx\cdot\frac{x}{3}$$

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE SECTIONAL FORCE OF SIMPLE GIRDER

PROGRAM NO.
P2-F-6

[Example]

$q_z = 7\ (t/m)$

$l = 15\ (m)$

$x = 2,\ 4,\ 8,\ 12,\ 14$

[Operation]

	CA		
(q_z) 7	S/E		
(l) 15	S/E	(W)	52.5
	S/E	(R_A)	17.5
	S/E	(R_B)	35
	S/E	(M_{MAX})	101.0362971
(x) 8	S/E	(Sc)	2.56666667
	S/E	(Mc)	100.1777777
	S/E		

Repeat

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	1	55	01	32		×		54
1	F	HLT	F	12	33	RM	1	65	01
2	x→M	2	55	02	34		÷		44
3	RM	1	65	01	35	RM	2	65	02
4		×		54	36		×		54
5	RM	2	65	02	37	RM	3	65	03
6		÷		44	38		÷		44
7		2		02	39		2		02
8		=		84	40		=		84
9	F	HLT	F	12	41	x→M	t	55	83
10		÷		44	42	RM	0	65	00
11		3		03	43		−		64
12		=		84	44	RM	t	65	83
13	x→M	0	55	00	45		=		84
14	F	HLT	F	12	46	F	HLT	F	12
15		×		54	47	RM	3	65	03
16		2		02	48		×		54
17		=		84	49	RM	0	65	00
18	F	HLT	F	12	50		=		84
19	RM	2	65	02	51	x→M	s	55	82
20	F	x^2	F	44	52	RM	3	65	03
21		×		54	53		÷		44
22	RM	1	65	01	54		3		03
23		÷		44	55		×		54
24		9		09	56	RM	t	65	83
25		÷		44	57		=		84
26		3		03	58		+/−		82
27	F	$\sqrt{}$	F	42	59	M+	s	75	82
28		=		84	60	RM	s	65	82
29	F LBL	s	F 13	82	61	GTO	t	14	83
30	F	HLT	F	12	62	F LBL	t	F 13	83
31	x→M	3	55	03	63	F	HLT	F	12

MEMORY			LABEL		
s		4	s		4
t		5	t	$\sqrt{}$	5
0	R_A	6	0		6
1	q	7	1		7
2	ℓ	8	2		8
3	x	9	3		9

STEP	KEY		KEY CODE		STEP	KEY	KEY CODE
64	GTO	s	14	82	96		
65		S/E		85	97		
66					98		
67					99		
68					100		
69					101		
70					102		
71					103		
72					104		
73					105		
74					106		
75					107		
76					108		
77					109		
78					110		
79					111		
80					112		
81					113		
82					114		
83					115		
84					116		
85					117		
86					118		
87					119		
88					120		
89					121		
90					122		
91					123		
92					124		
93					125		
94					126		
95					127		

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE QUANTITY AND VELOCITY OF THE FLOW (MANNING)

PROGRAM NO. P2–F–7

[Formula]

Manning's equation

$$V=\frac{1}{n}\cdot R^{\frac{2}{3}}\cdot I^{\frac{1}{2}}$$

V : Average velocity of flow (m/sec)
n : Manning's coefficient of roughness
R : Depth
I : Slope of the flow surface

R, h, ℓ, n → I, $C=\frac{1}{n}\cdot R^{\frac{1}{6}}$ (chez'y coefficient)

[Example]

R = 1.25 (m)
h = 2.13 (m)
ℓ = 10 (m)
n = 0.013

[Operation]

	CA		
(R) 1.25	S/E		
(h) 2.13	S/E		
(ℓ) 10	S/E		
(n) 0.013	S/E	(I)	0.213
	S/E	(c)	79.837755
	S/E	(v)	41.19581742

STEP	KEY		KEY CODE		STEP	KEY			KEY CODE	
0	x→M	1	55	01	32		GTO	t	14	83
1	F	HLT	F	12	33	F	LBL	t	F 13	83
2	x→M	2	55	02	34		F	HLT	F	12
3	F	HLT	F	12	35			S/E		85
4	x→M	3	55	03	36					
5	F	HLT	F	12	37					
6	x→M	4	55	04	38					
7	RM	2	65	02	39					
8		÷		44	40					
9	RM	3	65	03	41					
10		=		84	42					
11	x→M	5	55	05	43					
12	F	HLT	F	12	44					
13	RM	1	65	01	45					
14		y^x		31	46					
15		6		06	47					
16	F	$1/x$	F	43	48					
17		÷		44	49					
18	RM	4	65	04	50					
19		=		84	51					
20	F	HLT	F	12	52					
21	RM	1	65	01	53					
22	F	x^2	F	44	54					
23		y^x		31	55					
24		3		03	56					
25	F	$1/x$	F	43	57					
26		x		54	58					
27	RM	5	65	05	59					
28	F	$\sqrt{}$	F	42	60					
29		÷		44	61					
30	RM	4	65	04	62					
31		=		84	63					

MEMORY				LABEL			
s		4	n	s			4
t		5	I	t	$\sqrt{}$		5
0		6		0			6
1	R	7		1			7
2	h	8		2			8
3	ℓ	9		3			9

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE QUANTITY AND VELOCITY OF THE FLOW (HAZEN WILLIAMS)

PROGRAM NO. P2–F–8

[Formula]

Hazen Williams' equation (closed pipe)

$V = 0.35464\,C \cdot D^{0.63} I^{0.54}$ (Average velocity of flow (m/sec))

$Q = 0.27853\,C \cdot D^{2.63} I^{0.54}$ (Quantity of flow (m^3/sec))

$I = \frac{h}{l}$ (Slope of flow)

D : Diameter of pipe h : Heigh of flow

C : Coefficient of velocity l : Length of pipe

[Example]

D = 0.6 (m)

h = 2.13 (m)

l = 10 (m)

C = 100

[Operation]

CA

(D) 0.6 S/E

(h) 2.13 S/E

(l) 10 S/E

(C) 100 S/E (V) 11.1587755

S/E (Q) 3.153078284

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	1	55	01	32		=		84					
1	F	HLT	F	12	33	F	HLT	F	12					
2	x→M	2	55	02	34	RM	1	65	01					
3	F	HLT	F	12	35		y^x		31					
4	x→M	3	55	03	36		2		02					
5	F	HLT	F	12	37		·		83					
6	x→M	4	55	04	38		6		06					
7	RM	2	65	02	39		3		03					
8		÷		44	40		x		54					
9	RM	3	65	03	41	RM	0	65	00					
10		y^x		31	42		x		54					
11		·		83	43	RM	4	65	04					
12		5		05	44		x		54					
13		4		04	45		·		83					
14		=		84	46		2		02					
15	x→M	0	55	00	47		7		07					
16	RM	1	65	01	48		8		08					
17		y^x		31	49		5		05					
18		·		83	50		3		03					
19		6		06	51		=		84					
20		3		03	52	GTO	t	14	83					
21		x		54	53	F LBL	t	F 13	83					
22	RM	0	65	00	54	F	HLT	F	12					
23		x		54	55		S/E		85					
24		·		83	56									
25		3		03	57									
26		5		05	58									
27		4		04	59									
28		6		06	60									
29		4		04	61									
30		x		54	62									
31	RM	4	65	04	63									

MEMORY

s		4	C	
t		5		
0	I	6		
1	D	7		
2	h	8		
3	ℓ	9		

LABEL

s		4
t	√	5
0		6
1		7
2		8
3		9

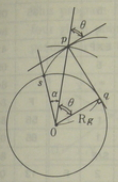
SHARP

ANGLE DESIGNATION: (DEG) RAD GRAD

TITLE: INVOLUTE, INVERSE INVOLUTE

PROGRAM NO.: P2–G–1

[Formula]



This program calculates the involute function necessary for the design of involute gear

$$\text{inv}\,\theta = \tan\theta - \theta(\text{RAD})$$

and also finds the inverse involute by Newton-method as shown below.

$$\theta_{i-1} = \theta_i - \frac{f(\theta_i)}{f'(\theta_i)}$$

$$= \theta_i - \frac{\tan\theta - \theta(\text{RAD})}{\tan^2\theta}$$

sp : Involute curve
s : Starting point of involute
θ : Angle of obliquite of action of point P

[Example]

degree	Invθ
14.10°	0.0050912……
23.00°	0.0230490……
25.53°	0.032035 ……

[Operation]

		CA				
(Initial condition θ_0)	10	S/E				
(inv θ)	0.00509	S/E	(θ)	14.09889742		
(θ)	14.10	GTO 2 S/E	(inv θ)	5.0912138×10^{-3}		

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
0		x→M	1	55	01	32			0		00
1		F	HLT	F	12	33			÷		44
2		x→M	2	55	02	34		F	π	F	41
3	F	LBL	t	F 13	83	35			=		84
4		RM	1	65	01	36		x→M	1	55	01
5			tan		24	37		RM	5	65	05
6		x→M	3	55	03	38			x		54
7		RM	1	65	01	39			EXP		41
8			x		54	40			5		05
9		F	π	F	41	41			=		84
10			÷		44	42		F	int	F	84
11			1		01	43	F	x≠0	t	F 55	83
12			8		08	44		RM	1	65	01
13			0		00	45			S/E		85
14			=		84	46	F	LBL	2	F 13	02
15		x→M	4	55	04	47		x→M	1	55	01
16		RM	3	65	03	48			tan		24
17			–		64	49		x→M	2	55	02
18		RM	4	65	04	50		RM	1	65	01
19			–		64	51			x		54
20		RM	2	65	02	52		F	π	F	41
21			÷		44	53			÷		44
22		RM	3	65	03	54			1		01
23		F	x^2	F	44	55			8		08
24			=		84	56			0		00
25		x→M	5	55	05	57			+/–		82
26		RM	4	65	04	58		M+	2	75	02
27			–		64	59		RM	2	65	02
28		RM	5	65	05	60			S/E		85
29			x		54	61					
30			1		01	62					
31			8		08	63					

MEMORY				LABEL			
s		4	θ_0 RAD	s			4
t		5	√	t	√		5
0		6		0			6
1	θ_0	7		1			7
2	inv θ	8		2	√		8
3	tan θ_0	9		3			9

SHARP

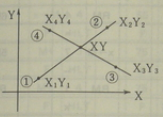
ANGLE DESIGNATION
(DEG) RAD GRAD

TITLE A POINT OF INTERSECTION AND PERPENDICULAR LINE

PROGRAM NO. P2-G-2

[Formula]

This program finds a point of intersection of two lines defined by the four given points or a line defined by the two given points and a perpendicular line through a given point.



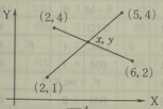
$$x=\frac{y_1-y_3+m_2x_3-m_1x_1}{m_2-m_1}$$

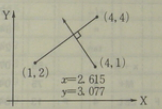
$$y=m_1(x-x_1)+y_1$$

$$m_1=\frac{y_2-y_1}{x_2-x_1}$$

$$m_2=\frac{y_4-y_3}{x_4-x_3}\left(\begin{array}{l}\text{in the case of}\\ \text{a perpendicular line}\\ m_2=-\frac{1}{m_1}\end{array}\right)$$

[Example]





[Operation]

		CA		in the case of a perpendicular line			
(X_1)	2	S/E	(X_1)	1	GTO	2	S/E
(Y_1)	1	S/E	(Y_1)	2	S/E		
(X_2)	5	S/E	(X_2)	4	S/E		
(Y_2)	4	S/E	(Y_2)	4	S/E		
(X_3)	6	S/E	(X_3)	4	S/E		
(Y_3)	2	S/E	(Y_3)	1	S/E	(X)	2.61538461
(X_4)	2	S/E			S/E	(Y)	3.076923078
(Y_4)	4	S/E	(X)	3.999999994			
		S/E	(Y)	3			

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0	F	GTS	1	F	14	01	32		RM	5		65	05
1			+/−			82	33		M+	8		75	08
2		x→M	8		55	08	34		RM	3		65	03
3		RM	5		65	05	35			×			54
4			+/−			82	36		RM	1		65	01
5		x→M	7		55	07	37			+/−			82
6		F	HLT		F	12	38		M+	8		75	08
7		M+	7		75	07	39		RM	8		65	08
8		F	HLT		F	12	40			÷			44
9		M+	8		75	08	41		RM	4		65	04
10	F	GTS	3	F	14	03	42			=			84
11		RM	7		65	07	43		x→M	7		55	07
12			↕			45	44			−			64
13		RM	8		65	08	45		RM	1		65	01
14		F	→rθ		F	64	46			×			54
15			↕			45	47		RM	3		65	03
16			+			74	48			+			74
17			EXP			41	49		RM	2		65	02
18			7			07	50			=			84
19			+/−			82	51		x→M	8		55	08
20			=			84	52		GTO	t		14	83
21			tan			24	53	F	LBL	t	F	13	83
22		x→M	7		55	07	54		RM	7		65	07
23		M+	4		75	04	55		F	HLT		F	12
24	F	LBL	4	F	13	04	56		RM	8		65	08
25		RM	2		65	02	57			S/E			85
26			−			64	58	F	LBL	2	F	13	02
27		RM	6		65	06	59	F	GTS	1	F	14	01
28			=			84	60	F	GTS	3	F	14	03
29		x→M	8		55	08	61		RM	4		65	04
30		RM	7		65	07	62		F	1/x		F	43
31			×			54	63		x→M	7		55	07

MEMORY

s		4	ΔY_1
t		5	x_3
0		6	y_3
1	x_1	7	ΔX_2
2	y_1	8	ΔY_2
3	ΔX_1	9	

LABEL

s		4	√
t	√	5	
0		6	
1	SUB	7	
2	√	8	
3	SUB	9	

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64		M+	4		75	04	96			+/−			82
65		GTO	4		14	04	97		x→M	4		55	04
66	F	LBL	1	F	13	01	98			S/E			85
67		x→M	1		55	01	99						
68			+/−			82	100						
69		x→M	3		55	03	101						
70		F	HLT		F	12	102						
71		x→M	2		55	02	103						
72			+/−			82	104						
73		x→M	4		55	04	105						
74		F	HLT		F	12	106						
75		M+	3		75	03	107						
76		F	HLT		F	12	108						
77		M+	4		75	04	109						
78		F	HLT		F	12	110						
79		x→M	5		55	05	111						
80		F	HLT		F	12	112						
81		x→M	6		55	06	113						
82			S/E			85	114						
83	F	LBL	3	F	13	03	115						
84		RM	3		65	03	116						
85			↕			45	117						
86		RM	4		65	04	118						
87		F	→rθ		F	64	119						
88			↕			45	120						
89			+			74	121						
90			EXP			41	122						
91			7			07	123						
92			+/−			82	124						
93			=			84	125						
94			tan			24	126						
95		x→M	3		55	03	127						

NOTE

SHARP

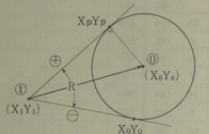
ANGLE DESIGNATION
(DEG) RAD GRAD

TITLE **A TANGENT LINE FROM ONE POINT**

PROGRAM NO. P2-G-3

[Formula]

This program finds a tangent point from a given point and a given circle. A given circle is defined by a radius and the center coordinate. One of the two tangent points is selected by the sign of R. (P for $R > 0$, Q for $R < 0$)



	R
P	+
Q	−

[Example]

In the case of P,

$x_1 = 0$, $y_1 = 0$, $x_0 = 2$, $y_0 = 2$, $R = 1$ given

$Xp = 1.0885621722$

$Yp = 2.4114378277$

Note: the sign of R: − for clock turn from ①⓪; + for anti-clock turn from ①⓪

[Operation]

	CA	
(x_1)	0 S/E	
(y_1)	0 S/E	
(x_0)	2 S/E	
(y_0)	2 S/E	
(R)	1 S/E	(X) 1.088562173
	S/E	(Y) 2.411437828

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	0	55	00	32	F	√	F	42
1		+/−		82	33		↕		45
2	x→M	2	55	02	34	RM	6	65	06
3	F	HLT	F	12	35	F	→xy	F	74
4	x→M	1	55	01	36	M+	0	75	00
5		+/−		82	37		↕		45
6	x→M	3	55	03	38	M+	1	75	01
7	F	HLT	F	12	39	GTO	t	14	83
8	M+	2	75	02	40 F	LBL	t	F 13	83
9	F	HLT	F	12	41	RM	0	65	00
10	M+	3	75	03	42	F	HLT	F	12
11	F	HLT	F	12	43	RM	1	65	01
12	x→M	4	55	04	44		S/E		85
13	RM	2	65	02	45				
14		↕		45	46				
15	RM	3	65	03	47				
16	F	→rθ	F	64	48				
17	x→M	5	55	05	49				
18		↕		45	50				
19	x→M	6	55	06	51				
20	RM	4	65	04	52				
21		÷		44	53				
22	RM	5	65	05	54				
23		=		84	55				
24	F	$\sin^{-1}$	F	22	56				
25	M+	6	75	06	57				
26	RM	5	65	05	58				
27	F	x^3	F	44	59				
28		−		64	60				
29	RM	4	65	04	61				
30	F	x^2	F	44	62				
31		=		84	63				

MEMORY				LABEL			
s		4	R	s		4	
t		5	γ	t		5	
0	X_1, X	6	θ_0	0		6	
1	Y_1, Y	7	α	1		7	
2	ΔX	8		2		8	
3	ΔY	9		3		9	

SHARP

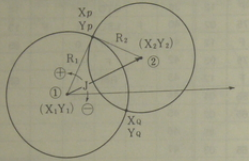
ANGLE DESIGNATION
DEG RAD GRAD

TITLE **A POINT OF INTERSECTION OF TWO CIRCLES**

PROGRAM NO. P2–G–4

[Formula]

This program finds a intersection from the two given circles. A point of two intersections is selected by the sign of R. (P for R > 0, Q for R < 0)



	J
P	+
Q	−

[Example]

In the case of P,

$R_1=2$
$X_1=1$
$Y_1=1$
$R_2=3.5$ | given
$X_2=-1$
$Y_2=2$
$J=0$

$\begin{pmatrix} Xp= & 0.8167\cdots\cdots \\ Yp= & -0.99158\cdots\cdots \end{pmatrix}$

Note) standard ①→②
J: inverse clockwise ㊀ +

[Operation]

		CA
(R_1)	2	S/E
(X_1)	1	S/E
(Y_1)	1	S/E
(R_2)	3.5	S/E
(X_2)	1 +/−	S/E
(Y_2)	2	S/E
(J)	0	S/E (X)
		S/E (Y)

8.167083353×10^{-1}
-0.991583331

STEP	KEY		KEY CODE	
0	x→M	0	55	00
1	F	HLT	F	12
2	x→M	1	55	01
3		+/−		82
4	x→M	3	55	03
5	F	HLT	F	12
6	x→M	2	55	02
7		+/−		82
8	x→M	4	55	04
9	F	HLT	F	12
10	x→M	5	55	05
11	F	HLT	F	12
12	M+	3	75	03
13	F	HLT	F	12
14	M+	4	75	04
15	F	HLT	F	12
16	x→M	6	55	06
17	RM	3	65	03
18		↕		45
19	RM	4	65	04
20	F	→rθ	F	64
21	x→M	3	55	03
22		↕		45
23	x→M	4	55	04
24	RM	0	65	00
25	F	x^2	F	44
26		+		74
27	RM	3	65	03
28	F	x^2	F	44
29		−		64
30	RM	5	65	05
31	F	x^2	F	44

STEP	KEY			KEY CODE	
32			÷		44
33			2		02
34			÷		44
35		RM	0	65	00
36			÷		44
37		RM	3	65	03
38			=		84
39		F	$\cos^{-1}$	F	23
40		x→M	3	55	03
41		RM	6	65	06
42	F	x<0	1	F 65	01
43		RM	3	65	03
44		M+	4	75	04
45		GTO	2	14	02
46	F	LBL	1	F 13	01
47		RM	3	65	03
48			+/−		82
49		M+	4	75	04
50	F	LBL	2	F 13	02
51		RM	0	65	00
52			↕		45
53		RM	4	65	04
54		F	→xy	F	74
55		M+	1	75	01
56			↕		45
57		M+	2	75	02
58		GTO	t	14	83
59	F	LBL	t	F 13	83
60		RM	1	65	01
61		F	HLT	F	12
62		RM	2	65	02
63			S/E		85

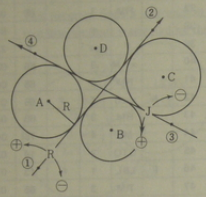
MEMORY				LABEL			
s		4	ΔY, θ	s		4	
t		5	R_2	t		5	
0	R_1	6	J	0		6	
1	X_1, Y	7		1	√	7	
2	Y_1, Y	8		2	√	8	
3	ΔX, γ	9		3		9	

SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD
PROGRAM NO.
P2-G-5

TITLE A TANGENT CIRCLE TO TWO LINES

[Formula]



This program finds a circle tangent to two lines, knowing a radius and four given points. One of the four circles is selected by the sign of R and J as the following table.

	R	J
A	+	+
B	−	+
C	−	−
D	+	−

[Example]

In the case of A,

X_1= 0 X_3=125
Y_1=109 Y_3=278
X_2=125 X_4=125
Y_2=278 Y_4=358
R= 50 J= 0

given (X = 74.99999997
Y =294.4818654

[Operation]

		CA
(X_1)	0	S/E
(Y_1)	109	S/E
(X_2)	125	S/E
(Y_2)	278	S/E
(R)	50	S/E
(X_3)	125	S/E
(Y_3)	278	S/E
(X_4)	125	S/E
(Y_4)	358	S/E
(J)	0	S/E 74.99999997
		S/E 294.4818654

Note: As a sign input of J, only +/− key is miss operation, therefor operate 0 , +/− key.

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	0	55	00	32	x→M	2	55	02
1		+/−		82	33		+		74
2	x→M	2	55	02	34		EXP		41
3	F	HLT	F	12	35		7		07
4	x→M	1	55	01	36		+/−		82
5		+/−		82	37		=		84
6	x→M	3	55	03	38		tan		24
7	F	HLT	F	12	39	x→M	3	55	03
8	M+	2	75	02	40		9		09
9	F	HLT	F	12	41		0		00
10	M+	3	75	03	42		+/−		82
11	F	HLT	F	12	43	M+	2	75	02
12	x→M	4	55	04	44	RM	4	65	04
13	F	HLT	F	12	45	F x<0	1	F 65	01
14	x→M	5	55	05	46		1		01
15		+/−		82	47		8		08
16	x→M	7	55	07	48		0		00
17	F	HLT	F	12	49	M+	2	75	02
18	x→M	6	55	06	50	F LBL	1	F 13	01
19		+/−		82	51	RM	4	65	04
20	x→M	8	55	08	52	F	abs	F	82
21	F	HLT	F	12	53		↕		45
22	M+	7	75	07	54	RM	2	65	02
23	F	HLT	F	12	55	F	→xy	F	74
24	M+	8	75	08	56	M+	0	75	00
25	F	HLT	F	12	57		↕		45
26	x→M	9	55	09	58	M+	1	75	01
27	RM	2	65	02	59	RM	7	65	07
28		↕		45	60		↕		45
29	RM	3	65	03	61	RM	8	65	08
30	F	→rθ	F	64	62	F	→rθ	F	64
31		↕		45	63		↕		45

MEMORY				LABEL			
s		4	R	s		4	
t		5	X_3	t	√	5	
0	X_1	6	Y_3	0		6	
1	Y_1	7	ΔX_3	1	√	7	
2	ΔX_1	8	ΔY_3 , m_2	2	√	8	
3	ΔY_1 , m_1	9	J	3		9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64	x→M	7	55	07	96	RM	8	65	08
65		+		74	97		x		54
66		EXP		41	98	RM	5	65	05
67		7		07	99	M+	2	75	02
68		+/−		82	100	RM	3	65	03
69		=		84	101		x		54
70		tan		24	102	RM	0	65	00
71	x→M	8	55	08	103		+/−		82
72		9		09	104	M+	2	75	02
73		0		00	105	RM	8	65	08
74		+/−		82	106		−		64
75	M+	7	75	07	107	RM	3	65	03
76	RM	9	65	09	108		÷		44
77	F x<0	2	F 65	02	109	RM	2	65	02
78		1		01	110		↕		45
79		8		08	111		=		84
80		0		00	112	x→M	2	55	02
81	M+	7	75	07	113		−		64
82	F LBL	2	F 13	02	114	RM	0	65	00
83	RM	4	65	04	115		x		54
84	F	abs	F	82	116	RM	3	65	03
85		↕		45	117		+		74
86	RM	7	65	07	118	RM	1	65	01
87	F	→xy	F	74	119		=		84
88	M+	5	75	05	120	x→M	4	55	04
89		↕		45	121	GTO	t	14	83
90	M+	6	75	06	122	F LBL	t	F 13	83
91	RM	1	65	01	123	RM	2	65	02
92		−		64	124	F	HLT	F	12
93	RM	6	65	06	125	RM	4	65	04
94		=		84	126		S/E		85
95	x→M	2	55	02	127				

NOTE

SHARP

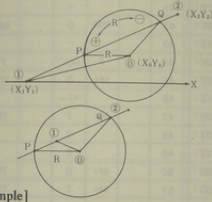
ANGLE DESIGNATION
(DEG) RAD GRAD
PROGRAM NO.
P2–G–6

TITLE INTERSECTION OF A CIRCLE AND A LINE

[Formula]

This program finds a point of intersection between a line (defined by the two given points) and a circle (defined by a given radius and a center coordinate).

A point of the two is selected by the sign of R (P for R > 0, Q for R < 0).



	R
P	+
Q	−

[Example]

In the case of P

$x_1 = 0$, $y_1 = 0$, $x_2 = 4$, $y_2 = 5$

$x_0 = 2$, $y_0 = 2$, $R = 1$

given → $\begin{pmatrix} x_p = 1.162657314 \\ y_p = 1.453321642 \end{pmatrix}$

[Operation]

	CA	
(x_1)	0 S/E	
(y_1)	0 S/E	
(x_2)	4 S/E	
(y_2)	5 S/E	
(x_0)	2 S/E	
(y_0)	2 S/E	
(R)	1 S/E	(X) 1.162657314
	S/E	(Y) 1.453321642

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		+/−		82	32		↕		45
1	x→M	0	55	00	33		+/−		82
2	x→M	2	55	02	34	M+	1	75	01
3	F	HLT	F	12	35	RM	1	65	01
4		+/−		82	36		sin		22
5	x→M	1	55	01	37		×		54
6	x→M	3	55	03	38	RM	2	65	02
7	F	HLT	F	12	39		=		84
8	M+	0	75	00	40	x→M	3	55	03
9	F	HLT	F	12	41		÷		44
10	M+	1	75	01	42	RM	6	65	06
11	F	HLT	F	12	43		=		84
12	x→M	4	55	04	44	F	$\cos^{-1}$	F	23
13	M+	2	75	02	45	M+	0	75	00
14	F	HLT	F	12	46		+/−		82
15	x→M	5	55	05	47	M+	7	75	07
16	M+	3	75	03	48		9		09
17	F	HLT	F	12	49		0		00
18	x→M	6	55	06	50	M+	0	75	00
19	RM	0	65	00	51	M+	7	75	07
20		↕		45	52	RM	6	65	06
21	RM	1	65	01	53	F $x<0$	2	F 65	02
22	F	→rθ	F	64	54	F	abs	F	82
23		↕		45	55		↕		45
24	x→M	0	55	00	56	RM	0	65	00
25	x→M	1	55	01	57	GTO	3	14	03
26	x→M	7	55	07	58	F LBL	2	F 13	02
27	RM	2	65	02	59	F	abs	F	82
28		↕		45	60		↕		45
29	RM	3	65	03	61	RM	7	65	07
30	F	→rθ	F	64	62	F LBL	3	F 13	03
31	x→M	2	55	02	63	F	→xy	F	74

MEMORY			
s		4	X
t		5	Y
0	x_2-x_1 $\overrightarrow{op}$	6	R
1	y_2-y_1 α	7	o$\hat{Q}$
2	X_0-X_1 β	8	
3	Y_0-Y_1 h	9	

LABEL	
s	4
t	5
0	6
1	7
2	8
3	9

STEP	KEY		KEY CODE		STEP	KEY	KEY CODE
64	M+	4	75	04	96		
65		↕		45	97		
66	M+	5	75	05	98		
67	GTO	t	14	83	99		
68	F LBL	t	F 13	83	100		
69	RM	4	65	04	101		
70	F	HLT	F	12	102		
71	RM	5	65	05	103		
72		S/E		85	104		
73					105		
74					106		
75					107		
76					108		
77					109		
78					110		
79					111		
80					112		
81					113		
82					114		
83					115		
84					116		
85					117		
86					118		
87					119		
88					120		
89					121		
90					122		
91					123		
92					124		
93					125		
94					126		
95					127		

NOTE

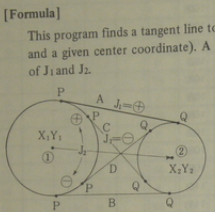
SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2-G-7

TITLE A TANGENT LINE TO TWO CIRCLES

[Formula]

This program finds a tangent line to two circles (defined by a given radius and a given center coordinate). A line of the four is selected by the signs of J_1 and J_2.



	J_1	J_2
A	+	+
B	+	−
C	−	+
D	−	−

J_1 circumscribed point +
inscribed point −
J_2 standard ①②
left +
right −

[Example] Example of circumscribed point P and Q.

$R_1=60$, $X_1=130$, $Y_1=210$, $R_2=30$, $X_2=220$, $Y_2=170$, $J_1=\oplus$, $J_2=\oplus$

given

$Xp=169.9113$
$Yp=254.8005$
$Xq=239.9557$
$Xq=192.4003$

[Operation]

		CA
(R_1)	60	S/E
(X_1)	130	S/E
(Y_1)	210	S/E
(R_2)	30	S/E
(X_2)	220	S/E
(Y_2)	170	S/E
(J_1)	0	S/E
(J_2)	0	S/E
		S/E (X_p) 169.9113357
		S/E (Y_p) 254.8005053
		S/E (X_q) 239.9556678
		S/E (Y_q) 192.4002526

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0		x→M	0		55	00	32			2			02
1		x→M	s		55	82	33			x			54
2		F	HLT		F	12	34		RM	0		65	00
3		x→M	1		55	01	35			+/−			82
4			+/−			82	36		M+	s		75	82
5		x→M	3		55	03	37	F	LBL	1	F	13	01
6		F	HLT		F	12	38		RM	s		65	82
7		x→M	2		55	02	39			÷			44
8			+/−			82	40		RM	3		65	03
9		x→M	4		55	04	41			=			84
10		F	HLT		F	12	42		F	$\sin^{-1}$		F	22
11		x→M	5		55	05	43		x→M	s		55	82
12		M+	s		75	82	44		RM	8		65	08
13		F	HLT		F	12	45	F	$x<0$	2	F	65	02
14		x→M	6		55	06	46			9			09
15		M+	3		75	03	47			0			00
16		F	HLT		F	12	48			+			74
17		x→M	7		55	07	49		RM	s		65	82
18		M+	4		75	04	50			=			84
19		F	HLT		F	12	51			+/−			82
20		x→M	8		55	08	52		M+	4		75	04
21		F	HLT		F	12	53		RM	9		65	09
22		x→M	9		55	09	54	F	$x<0$	3	F	65	03
23		RM	3		65	03	55			2			02
24			‡			45	56			x			54
25		RM	4		65	04	57		RM	s		65	82
26		F	$\rightarrow r\theta$		F	64	58		M+	4		75	04
27		x→M	3		55	03	59			1			01
28			‡			45	60			8			08
29		x→M	4		55	04	61			0			00
30		RM	8		65	08	62		M+	4		75	04
31	F	$x<0$	1	F	65	01	63	F	LBL	3	F	13	03

MEMORY					LABEL			
s	α	4	θ_2		s		4	√
t		5	R_2		t	√	5	
0	R_1	6	X_2		0		6	
1	X_1	7	Y_2		1	√	7	
2	Y_1	8	J_1		2	√	8	
3	γ	9	J_2		3	√	9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64	RM	4	65	04	96	M+	1	75	01
65	x→M	3	55	03	97		‡		45
66	GTO	4	14	04	98	M+	2	75	02
67	F LBL	2	F 13	02	99	RM	5	65	05
68	RM	s	65	82	100		‡		45
69	M+	4	75	04	101	RM	4	65	04
70	RM	4	65	04	102	F	→xy	F	74
71	x→M	3	55	03	103	M+	6	75	06
72		9		09	104		‡		45
73		0		00	105	M+	7	75	07
74	M+	4	75	04	106	GTO	t	14	83
75		+/−		82	107	F LBL	t	F 13	83
76	M+	3	75	03	108	RM	1	65	01
77	RM	9	65	09	109	F	HLT	F	12
78	F x<0	4	F 65	04	110	RM	2	65	02
79		2		02	111	F	HLT	F	12
80		x		54	112	RM	6	65	06
81	RM	s	65	82	113	F	HLT	F	12
82		+/−		82	114	RM	7	65	07
83	M+	3	75	03	115		S/E		85
84	M+	4	75	04	116				
85		1		01	117				
86		8		08	118				
87		0		00	119				
88	M+	3	75	03	120				
89		+/−		82	121				
90	M+	4	75	04	122				
91	F LBL	4	F 13	04	123				
92	RM	0	65	00	124				
93		‡		45	125				
94	RM	3	65	03	126				
95	F	→xy	F	74	127				

NOTE

SHARP

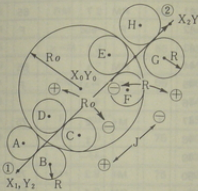
ANGLE DESIGNATION (DEG) RAD GRAD

PROGRAM NO. P2-G-8

TITLE A TANGENT CIRCLE TO BOTH A CIRCLE AND A LINE

[Formula]

This program finds a circle of the given radius tangent to both a line (defined by the two given points) and a circle (defined by a given radius and a center coordinate). A circle of the eight is selected by the signs of R_0, R and J as the following table.



	R_0	R	J
A	+	+	+
B	−	+	+
C	−	−	+
D	+	−	+
E	+	−	−
F	−	−	−
G	−	+	−
H	+	+	−

[Example]

In the case of B

$X_1 = 509$ $Y_1 = 0$ $X_2 = 509$ $Y_2 = 200$ $X_0 = 419$ $Y_0 = 382$ $R_0 = -240$ $R = 100$ $J = 0$ given $X_B = 609$ $Y_B = 100.0426$

[Operation]

		CA
(X_1)	509	S/E
(Y_1)	0	S/E
(X_2)	509	S/E
(Y_2)	200	S/E
(X_0)	419	S/E
(Y_0)	382	S/E
(R_0)	240	+/− S/E
(R)	100	S/E
(J)	0	S/E (X) 609.0000002
		S/E (Y) 100.0425565

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		+/−		82	32		+/−		82	64	F	abs	F	82
1	x→M	0	55	00	33	M+	s	75	82	65		+		74
2	x→M	2	55	02	34	RM	6	65	06	66	RM	7	65	07
3	F	HLT	F	12	35	F $x<0$	1	F 65	01	67		=		84
4		+/−		82	36		1		01	68	F	abs	F	82
5	x→M	1	55	01	37		8		08	69	x→M	6	55	06
6	x→M	3	55	03	38		0		00	70	RM	1	65	01
7	F	HLT	F	12	39	M+	s	75	82	71		sin		22
8	M+	0	75	00	40	F LBL	1	F 13	01	72		x		54
9	F	HLT	F	12	41	RM	7	65	07	73	RM	2	65	02
10	M+	1	75	01	42	F	abs	F	82	74		=		84
11	F	HLT	F	12	43		↕		45	75	x→M	3	55	03
12	x→M	4	55	04	44	RM	s	65	82	76		÷		44
13	F	HLT	F	12	45	F	$\rightarrow xy$	F	74	77	RM	6	65	06
14	x→M	5	55	05	46		+/−		82	78		=		84
15	F	HLT	F	12	47	M+	2	75	02	79	F	$\cos^{-1}$	F	23
16	x→M	6	55	06	48		↕		45	80	M+	0	75	00
17	F	HLT	F	12	49		+/−		82	81		+/−		82
18	x→M	7	55	07	50	M+	3	75	03	82	M+	9	75	09
19	F	HLT	F	12	51	RM	4	65	04	83		9		09
20	x→M	8	55	08	52	M+	2	75	02	84		0		00
21	RM	0	65	00	53	RM	5	65	05	85	M+	0	75	00
22		↕		45	54	M+	3	75	03	86	M+	9	75	09
23	RM	1	65	01	55	RM	2	65	02	87	RM	8	65	08
24	F	$\rightarrow r\theta$	F	64	56		↕		45	88	F $x<0$	3	F 65	03
25		↕		45	57	RM	3	65	03	89	RM	0	65	00
26	x→M	0	55	00	58	F	$\rightarrow r\theta$	F	64	90	GTO	4	14	04
27	x→M	1	55	01	59	x→M	2	55	02	91	F LBL	3	F 13	03
28	x→M	9	55	09	60		↕		45	92	RM	9	65	09
29	x→M	s	55	82	61		+/−		82	93	F LBL	4	F 13	04
30		9		09	62	M+	1	75	01	94		↕		45
31		0		00	63	RM	6	65	06	95	RM	6	65	06

MEMORY				LABEL			
s	$\theta_2 \pm 90$	4	X_0	s		4	√
t		5	Y_0	t	√	5	
0	ΔX_1 , $\overrightarrow{op}$	6	R_0	0		6	
1	ΔY_1	7	R	1	√	7	
2	ΔX_2	8	J	2	√	8	
3	ΔY_2	9	$\overrightarrow{OQ}$	3	√	9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
96		↕		45	128				
97	F	$\rightarrow xy$	F	74	129				
98	M+	4	75	04	130				
99		↕		45	131				
100	M+	5	75	05	132				
101	GTO	t	14	83	133				
102	F LBL	t	F 13	83	134				
103	RM	4	65	04	135				
104	F	HLT	F	12	136				
105	RM	5	65	05	137				
106		S/E		85	138				
107					139				
108					140				
109					141				
110					142				
111					143				
112					144				
113					145				
114					146				
115					147				
116					148				
117					149				
118					150				
119					151				
120					152				
121					153				
122					154				
123					155				
124					156				
125					157				
126					158				
127					159				

NOTE

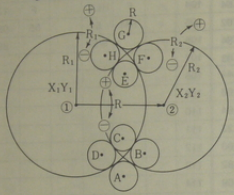
SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD
PROGRAM NO.
P2-G-9

TITLE **A TANGENT CIRCLE TO TWO CIRCLES**

[Formula]

This program finds a circle of the given radius tangent to two circles (defined by a given radius and a given center coordinate). A circle of the eight is selected by the signs of R_1, R_2 and R as the following table.



	R_1	R_2	R
A	+	+	−
B	+	−	−
C	−	−	−
D	−	+	−
E	−	−	+
F	+	−	+
G	+	+	+
H	−	+	+

[Example] In the case of A

$R_1 = 50$
$X_1 = 90$
$Y_1 = 120$
$R_2 = 30$
$X_2 = 90$
$Y_2 = 160$
$R = -10$

given $\begin{cases} X = 129.6863 \\ Y = 165. \end{cases}$

[Operation]

	CA	
(R_1)	50 S/E	
(X_1)	90 S/E	
(Y_1)	120 S/E	
(R_2)	30 S/E	
(X_2)	90 S/E	
(Y_2)	160 S/E	
(R)	10 +/− S/E	(X) 129.6862696
	S/E	(Y) 165.

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	0	55	00	32	F	abs	F	82
1	F	HLT	F	12	33		+		74
2	x→M	1	55	01	34	RM	5	65	05
3		+/−		82	35		=		84
4	x→M	3	55	03	36	x→M	5	55	05
5	F	HLT	F	12	37	RM	0	65	00
6	x→M	2	55	02	38	F	x^2	F	44
7		+/−		82	39		+		74
8	x→M	4	55	04	40	RM	3	65	03
9	F	HLT	F	12	41	F	x^3	F	44
10	x→M	5	55	05	42		−		64
11	F	HLT	F	12	43	RM	5	65	05
12	M+	3	75	03	44	F	x^2	F	44
13	F	HLT	F	12	45		÷		44
14	M+	4	75	04	46		2		02
15	F	HLT	F	12	47		÷		44
16	x→M	6	55	06	48	RM	0	65	00
17	RM	3	65	03	49		÷		44
18		↕		45	50	RM	3	65	03
19	RM	4	65	04	51		=		84
20	F	→rθ	F	64	52	F	$\cos^{-1}$	F	23
21	x→M	3	55	03	53	x→M	3	55	03
22		↕		45	54		+/−		82
23	x→M	4	55	04	55	M+	4	75	04
24	RM	6	65	06	56	RM	6	65	06
25	F	abs	F	82	57	F x<0	1	F 65	01
26		+		74	58	RM	3	65	03
27	RM	0	65	00	59		x		54
28		=		84	60		2		02
29	F	abs	F	82	61	M+	4	75	04
30	x→M	0	55	00	62	F LBL	1	F 13	01
31	RM	6	65	06	63	RM	0	65	00

MEMORY				LABEL			
s		4	ΔY	s		4	
t		5	R_2	t	√	5	
0	R_1	6	R	0		6	
1	X_1	7		1	√	7	
2	Y_1	8		2		8	
3	ΔX	9		3		9	

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64			↕			45	96						
65		RM	4		65	04	97						
66		F	$\rightarrow xy$		F	74	98						
67		M+	1		75	01	99						
68			↕			45	100						
69		M+	2		75	02	101						
70		GTO	t		14	83	102						
71	F	LBL	t	F	13	83	103						
72		RM	1		65	01	104						
73		F	HLT		F	12	105						
74		RM	2		65	02	106						
75			S/E			85	107						
76							108						
77							109						
78							110						
79							111						
80							112						
81							113						
82							114						
83							115						
84							116						
85							117						
86							118						
87							119						
88							120						
89							121						
90							122						
91							123						
92							124						
93							125						
94							126						
95							127						

NOTE

SHARP

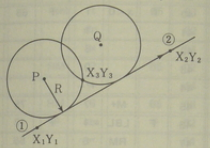
ANGLE DESIGNATION: (DEG) RAD GRAD

PROGRAM NO. P2–G–10

TITLE A TANGENT CIRCLE THROUGH ONE POINT TO A LINE

[Formula]

This program finds a tangent circle with a given radius through a given point to a line (defined by the two given points). A circle of the two is selected by the sign of R (P for $R > 0$, Q for $R < 0$).



	R
P	+
Q	−

[Example] In the case of P (closer point to ①),

$X_1 = 60$
$Y_1 = 10$
$X_2 = 100$
$Y_2 = 50$
$X_3 = 60$
$Y_3 = 30$
$R = 50$

given ($X_P = 10.005$, $Y_P = 30.715$)

[Operation]

		CA
(X_1)	60	S/E
(Y_1)	10	S/E
(X_2)	100	S/E
(Y_2)	50	S/E
(X_3)	60	S/E
(Y_3)	30	S/E
(R)	50	S/E (X) 10.00512398
		S/E (Y) 30.71580211

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		+/−		82	32		F	→rθ		F	64
1	x→M	0	55	00	33			↕			45
2	x→M	2	55	02	34			+/−			82
3	x→M	8	55	08	35		M+	1		75	01
4	F	HLT	F	12	36			9			09
5		+/−		82	37			0			00
6	x→M	1	55	01	38		M+	7		75	07
7	x→M	3	55	03	39		RM	1		65	01
8	x→M	9	55	09	40	F	x<0	1	F	65	01
9	F	HLT	F	12	41			1			01
10	M+	0	75	00	42			8			08
11	F	HLT	F	12	43			0			00
12	M+	1	75	01	44			+/−			82
13	F	HLT	F	12	45		M+	7		75	07
14	x→M	4	55	04	46	F	LBL	1	F	13	01
15	M+	2	75	02	47		RM	6		65	06
16	F	HLT	F	12	48		F	abs		F	82
17	x→M	5	55	05	49			↕			45
18	M+	3	75	03	50		RM	7		65	07
19	F	HLT	F	12	51		F	→xy		F	74
20	x→M	6	55	06	52			+/−			82
21	RM	0	65	00	53		M+	8		75	08
22		↕		45	54			↕			45
23	RM	1	65	01	55			+/−			82
24	F	→rθ	F	64	56		M+	9		75	09
25		↕		45	57		RM	4		65	04
26	x→M	0	55	00	58		M+	8		75	08
27	x→M	1	55	01	59		RM	5		65	05
28	x→M	7	55	07	60		M+	9		75	09
29	RM	2	65	02	61		RM	0		65	00
30		↕		45	62		x→M	7		55	07
31	RM	3	65	03	63		x→M	t		55	83

MEMORY			
s		4	X_3
t	α	5	Y_3
0	ΔX, $\overline{OP}$	6	R
1	ΔY_1	7	$\overline{OQ}$
2	ΔX_2	8	ΔX_3
3	ΔY_2	9	ΔY_3

LABEL			
s		4	√
t	√	5	
0		6	
1	√	7	
2	√	8	
3	√	9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64	RM	8	65	08	96	RM	6	65	06
65		↕		45	97	F	abs	F	82
66	RM	9	65	09	98		↕		45
67	F	→rθ	F	64	99	F	→xy	F	74
68	x→M	2	55	02	100	M+	4	75	04
69		↕		45	101		↕		45
70		+/−		82	102	M+	5	75	05
71	M+	t	75	83	103	GTO	t	14	83
72	RM	t	65	83	104	F LBL	t	F 13	83
73		sin		22	105	RM	4	65	04
74		x		54	106	F	HLT	F	12
75	RM	2	65	02	107	RM	5	65	05
76		÷		44	108		S/E		85
77	RM	6	65	06	109				
78	F	abs	F	82	110				
79		=		84	111				
80	F	$\cos^{-1}$	F	23	112				
81	M+	0	75	00	113				
82		+/−		82	114				
83	M+	7	75	07	115				
84		9		09	116				
85		0		00	117				
86	M+	0	75	00	118				
87	M+	7	75	07	119				
88	RM	6	65	06	120				
89	F x<0	3	F 65	03	121				
90	RM	0	65	00	122				
91	GTO	4	14	04	123				
92	F LBL	3	F 13	03	124				
93	RM	7	65	07	125				
94	F LBL	4	F 13	04	126				
95		↕		45	127				

NOTE

SHARP

ANGLE DESIGNATION
(DEG) RAD GRAD

PROGRAM NO.
P2–G–11

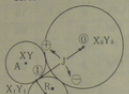
TITLE A TANGENT CIRCLE THROUGH ONE POINT TO A CIRCLE

[Formula]

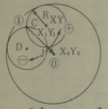
This program finds a tangent circle with a given radius through a given point to a circle (defined by a given radius and a center coordinate). A circle of the two is selected by the signs of R and J as follows.

R: circumscribed +
inscribed −

J: standard ①→⓪
left +
right −



	R	J
A	+	+
B	+	−
C	−	+
D	−	−



[Example] In the case of A

$R = 10$ $R_0 = 20$
$X_1 = 40$ $X_0 = 50$
$Y_1 = 50$ $Y_0 = 30$
$J = 0$

given → $X = 43.633\cdots\cdots$, $Y = 59.316\cdots\cdots$

[Operation]

		CA
(R)	10	S/E
(X_1)	40	S/E
(Y_1)	50	S/E
(R_0)	20	S/E
(X_0)	50	S/E
(Y_0)	30	S/E
(J)	0	S/E
		S/E

(X) 43.63324957

(Y) 59.31662479

STEP	KEY		KEY CODE	
0	x→M	5	55	05
1	F	abs	F	82
2	x→M	0	55	00
3	F	HLT	F	12
4	x→M	1	55	01
5		+/−	82	
6	x→M	3	55	03
7	F	HLT	F	12
8	x→M	2	55	02
9		+/−	82	
10	x→M	4	55	04
11	F	HLT	F	12
12	M+	5	75	05
13	F	HLT	F	12
14	M+	3	75	03
15	F	HLT	F	12
16	M+	4	75	04
17	F	HLT	F	12
18	x→M	6	55	06
19	RM	3	65	03
20		↕	45	52
21	RM	4	65	04
22	F	$\rightarrow r\theta$	F	64
23	x→M	3	55	03
24		↕	45	56
25	x→M	4	55	04
26	RM	0	65	00
27	F	x^2	F	44
28		+	74	60
29	RM	3	65	03
30	F	x^2	F	44
31		−	64	63

STEP	KEY			KEY CODE	
32		RM	5	65	05
33		F	x^3	F	44
34			÷		44
35			2		02
36			÷		44
37		RM	0	65	00
38			÷		44
39		RM	3	65	03
40			=		84
41		F	$\cos^{-1}$	F	23
42		x→M	5	55	05
43			+/−		82
44		M+	4	75	04
45		RM	6	65	06
46	F	$x<0$	1	F 65	01
47			2		02
48			x		54
49		RM	5	65	05
50		M+	4	75	04
51	F	LBL	1	F 13	01
52		RM	0	65	00
53			↕		45
54		RM	4	65	04
55		F	$\rightarrow xy$	F	74
56		M+	1	75	01
57			↕		45
58		M+	2	75	02
59		RM	1	65	01
60		F	HLT	F	12
61		RM	2	65	02
62			S/E		85
63					

MEMORY

s		4	ΔY
t		5	$R_0 \pm R$
0	R	6	
1	X_1	7	
2	Y_1	8	
3	ΔX	9	

LABEL

s		4
t	√	5
0		6
1	√	7
2		8
3		9

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **MONEY EXCHANGE**

PROGRAM NO. P2-H-1

[Formula]

This program is used for money exchange. Before exchanging, pre-set for exchange rate.

[Operation]

Input	Key operation	Display
1)	CA	0.
2)	GTO 8 S/E	0.
3) exchange rate	dollar S/E	dollar
	pound S/E	pound
	franc S/E	franc
	mark S/E	mark

〔1〕 Yen to Dollar

1)		CA	0.
2)	Yen	S/E	Dollar

Repeat the same operation as shown above.

〔2〕 Yen to Pound

1)		CA	0.
2)		GTO 1 S/E	0.
3)	Yen	S/E	Pound

Repeat the same operation as shown above.

〔3〕 Yen to Franc

1)		CA	0.
2)		GTO 2 S/E	0.
3)	Yen	S/E	Franc

Repeat the same operation as shown above.

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **MONEY EXCHANGE**

PROGRAM NO. P2-H-1

〔4〕 Yen to Mark

1)		CA	0.
2)		GTO 3 S/E	0.
3)	Yen	S/E	Mark

Repeat the same operation as shown above.

〔5〕 Dollar to Yen

1)		CA	0.
2)		GTO 4 S/E	0.
3)	Dollar	S/E	Yen

Repeat the same operation as shown above.

〔6〕 Pound to Yen

1)		CA	0.
2)		GTO 5 S/E	0.
3)	Pound	S/E	Yen

Repeat the same operation as shown above.

〔7〕 Franc to Yen

1)		CA	0.
2)		GTO 6 S/E	0.
3)	Franc	S/E	Yen

Repeat the same operation as shown above.

〔8〕 Mark to Yen

1)		CA	0.
2)		GTO 7 S/E	0.
3)	Mark	S/E	Yen

Repeat the same operation as shown above.

Note:

1) After Pre-Set exchange rate, do not operate F CAM.
2) All the calculation are rounded down to two digits of decimals.
3) This program can be used in any kind of money exchange rate up to five kinds.

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0			÷			44	32		RM	0		65	00
1		RM	0		65	00	33			=			84
2			=			84	34	F	GTS	9	F	14	09
3	F	GTS	9	F	14	09	35		GTO	4		14	04
4			S/E			85	36			S/E			85
5	F	LBL	1	F	13	01	37	F	LBL	5	F	13	05
6		F	HLT		F	12	38		F	HLT		F	12
7			÷			44	39			x			54
8		RM	1		65	01	40		RM	1		65	01
9			=			84	41			=			84
10	F	GTS	9	F	14	09	42	F	GTS	9	F	14	09
11		GTO	1		14	01	43		GTO	5		14	05
12			S/E			85	44			S/E			85
13	F	LBL	2	F	13	02	45	F	LBL	6	F	13	06
14		F	HLT		F	12	46		F	HLT		F	12
15			÷			44	47			x			54
16		RM	2		65	02	48		RM	2		65	02
17			=			84	49			=			84
18	F	GTS	9	F	14	09	50	F	GTS	9	F	14	09
19		GTO	2		14	02	51		GTO	6		14	06
20			S/E			85	52			S/E			85
21	F	LBL	3	F	13	03	53	F	LBL	7	F	13	07
22		F	HLT		F	12	54		F	HLT		F	12
23			÷			44	55			x			54
24		RM	3		65	03	56		RM	3		65	03
25			=			84	57			=			84
26	F	GTS	9	F	14	09	58	F	GTS	9	F	14	09
27		GTO	3		14	03	59		GTO	7		14	07
28			S/E			85	60			S/E			85
29	F	LBL	4	F	13	04	61	F	LBL	9	F	13	09
30		F	HLT		F	12	62		x→M	4		55	04
31			x			54	63		F	frac		F	83

MEMORY				LABEL			
s		4	√	s		4	√
t		5	√	t		5	√
0	√	6		0		6	√
1	√	7		1	√	7	√
2	√	8		2	√	8	√
3	√	9		3	√	9	√

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64			x			54	96						
65			EXP			41	97						
66			2			02	98						
67			=			84	99						
68		F	int		F	84	100						
69			÷			44	101						
70			EXP			41	102						
71			2			02	103						
72			=			84	104						
73		x→M	5		55	05	105						
74		RM	4		65	04	106						
75		F	int		F	84	107						
76			+			74	108						
77		RM	5		65	05	109						
78			=			84	110						
79			S/E			85	111						
80	F	LBL	8	F	13	08	112						
81		F	HLT		F	12	113						
82		x→M	0		55	00	114						
83		F	HLT		F	12	115						
84		x→M	1		55	01	116						
85		F	HLT		F	12	117						
86		x→M	2		55	02	118						
87		F	HLT		F	12	119						
88		x→M	3		55	03	120						
89			S/E			85	121						
90							122						
91							123						
92							124						
93							125						
94							126						
95							127						

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2-H-2

TITLE **DAYS BETWEEN DATES**

[Formula]

This program calculates the number of days from standard date which is Pre-set before the calculation. (the number of days includes one side date)

[Example]

1) From 10/5/1976 to 2/20/1977
2) From 10/5/1976 to 11/15/1977

[Operation]

	Input	Key operation	Display
1)		CA F CAM	0.
2)		GTO 1 S/E	0.
3)	Standard date	19761005 S/E	0.
4)		19770220 S/E	138 (days)
5)		19771115 S/E	406 (days)

Repeat the same operation as shown above

Note:

1) Before Pre-Set new standard date, F CAM should be operated.
2) All the months and dates should be operated by two digits number.

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0		x→M	1		55	01	32			S/E			85
1	F	GTS	2	F	14	02	33	F	LBL	2	F	13	02
2		RM	3		65	03	34		RM	1		65	01
3			+			74	35			÷			44
4			1			01	36			EXP			41
5			=			84	37			4			04
6		x→M	3		55	03	38			=			84
7	F	GTS	3	F	14	03	39		F	int		F	84
8	F	GTS	6	F	14	06	40		x→M	3		55	03
9			S/E			85	41			x			54
10	F	LBL	1	F	13	01	42			EXP			41
11		F	HLT		F	12	43			4			04
12		x→M	1		55	01	44			=			84
13	F	GTS	2	F	14	02	45			+/−			82
14	F	GTS	3	F	14	03	46		M+	1		75	01
15		RM	3		65	03	47		RM	1		65	01
16			÷			44	48			÷			44
17			1			01	49			EXP			41
18			0			00	50			2			02
19			0			00	51			=			84
20			=			84	52		F	int		F	84
21		F	int		F	84	53		x→M	2		55	02
22			+/−			82	54			x			54
23		M+	1		75	01	55			EXP			41
24			÷			44	56			2			02
25			4			04	57			=			84
26			=			84	58			+/−			82
27		F	int		F	84	59		M+	1		75	01
28			+/−			82	60		RM	2		65	02
29		M+	1		75	01	61			−			64
30	F	GTS	6	F	14	06	62			3			03
31		GTO	1		14	01	63			=			84

s	MEMORY				LABEL			
t		4	√		s		4	√
0		5			t		5	√
1		6	√		0		6	√
2	√	7			1	√	7	√
3	√	8			2	√	8	
	√	9			3	√	9	

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64		x→M	4		55	04	96			5			05
65		RM	4		65	04	97			·			83
66	F	x<0	4	F	65	04	98			2			02
67	F	LBL	5	F	13	05	99			5			05
68		RM	4		65	04	100			=			84
69			×			54	101		F	int		F	84
70			3			03	102		M+	1		75	01
71			0			00	103			S/E			85
72			6			06	104	F	LBL	6	F	13	06
73			+			74	105		RM	6		65	06
74			5			05	106	F	x<0	7	F	65	07
75			÷			44	107		RM	1		65	01
76			1			01	108			+/−			82
77			0			00	109		x→M	6		55	06
78			=			84	110			C·CE			35
79		F	int		F	84	111			S/E			85
80		M+	1		75	01	112	F	LBL	7	F	13	07
81			S/E			85	113		RM	6		65	06
82	F	LBL	4	F	13	04	114			+			74
83			1			01	115		RM	1		65	01
84			2			02	116			=			84
85		M+	4		75	04	117			S/E			85
86			1			01	118						
87			+/−			82	119						
88		M+	3		75	03	120						
89		GTO	5		14	05	121						
90			S/E			85	122						
91	F	LBL	3	F	13	03	123						
92		RM	3		65	03	124						
93			×			54	125						
94			3			03	126						
95			6			06	127						

NOTE

SHARP

DEG RAD GRAD

PROGRAM NO. P2–H–3

TITLE **CALCULATION OF FUTURE DATE**

[Formula]

This program calculates reverse for the number of days.
(The number of days includes one side date)

[Example]

1) After 100 days from 3/10/ 1977
2) Before 100 days from 3/10/1977

[Operation]

Input	Key operation		Display
1)		CA	0.
2) Standard year	1977	S/E	1977.
3) Standard month	3	S/E	3.
4) Standard date	10	S/E	0.
5) After 100 days	100	S/E	1977 (year)
		S/E	6 (month)
		S/E	18 (date)

Repeat the same operation as shown above.

Note:

1) This program is able to calculate between 1950 to 2000 years.
2) To find n days before from the standard date, n should be operated as a negative number like n +/− S/E .

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		x→M	1	55 01	32		+/−		82	64		=		84 96
1		F	HLT	F 12	33		M+	1	75 01	65	F	x<0	3	F 65 03
2		x→M	2	55 02	34	F	LBL	2	F 13 02	66		RM	1	65 01
3		F	HLT	F 12	35			1	01	67		x→M	5	55 05
4		x→M	3	55 03	36		M+	2	75 02	68		RM	2	65 02
5	F	GTS	s	F 14 82	37	F	GTS	s	F 14 82	69			+	74
6		x→M	9	55 09	38			−	64	70			1	01
7			C/CE	35	39		RM	7	65 07	71			=	84
8	F	LBL	0	F 13 00	40			=	84	72		x→M	6	55 06
9		F	HLT	F 12	41	F	x<0	2	F 65 02	73		GTO	4	14 04
10			+	74	42			1	01	74	F	LBL	3	F 13 03
11		RM	9	65 09	43			+/−	82	75		RM	1	65 01
12			=	84	44		M+	2	75 02	76			−	64
13		x→M	7	55 07	45	F	GTS	s	F 14 82	77			1	01
14			1	01	46			−	64	78			=	84
15			9	09	47		RM	7	65 07	79		x→M	5	55 05
16			5	05	48			‡	45	80		RM	2	65 02
17			0	00	49			=	84	81			+	74
18		x→M	1	55 01	50		x→M	3	55 03	82			1	01
19			1	01	51		GTO	t	14 83	83			3	03
20		x→M	2	55 02	52	F	LBL	t	F 13 83	84			=	84
21			0	00	53		RM	1	65 01	85		x→M	6	55 06
22		x→M	3	55 03	54		F	HLT	F 12	86	F	LBL	4	F 13 04
23	F	LBL	1	F 13 01	55		RM	2	65 02	87			3	03
24			1	01	56		F	HLT	F 12	88			6	06
25		M+	1	75 01	57		RM	3	65 03	89			5	05
26	F	GTS	s	F 14 82	58		GTO	0	14 00	90			·	83
27			−	64	59			S/E	85	91			2	02
28		RM	7	65 07	60	F	LBL	s	F 13 82	92			5	05
29			=	84	61		RM	2	65 02	93			x	54
30	F	x<0	1	F 65 01	62			−	64	94		RM	5	65 05
31			1	01	63			3	03	95			=	84

MEMORY

s		4	
t		5	√
0		6	√
1	√	7	√
2	√	8	√
3	√	9	

LABEL

s	√	4	√
t	√	5	
0	√	6	
1	√	7	
2	√	8	
3	√	9	

STEP	KEY		KEY CODE	STEP	KEY		KEY CODE
96		F	int	97		F	84
97		x→M	8	98			55 08
98			3	99			03
99			0	100			00
100			·	101			83
101			6	102			06
102			x	103			54
103		RM	6	104			65 06
104			=	105			84
105		F	int	106			F 84
106		M+	8	107			75 08
107		RM	8	108			65 08
108			+	109			74
109		RM	3	110			65 03
110			−	111			64
111			6	112			06
112			2	113			02
113			1	114			01
114			0	115			00
115			4	116			04
116			9	117			09
117			=	118			84
118			S/E	119			85
119				120			
120				121			
121				122			
122				123			
123				124			
124				125			
125				126			
126							

NOTE

SHARP

ANGLE DESIGNATION: DEG RAD GRAD

TITLE PRESENT VALUE & PAYMENT FOR AN ANNUITY (by compound interest)

PROGRAM NO. P2-H-4

[Formula]

1) Present value of annuity
(pay at the end of every term)

$$P = R \times \frac{1-(1+i)^{-n}}{i}$$

2) Present value of annuity
(pay at the top of every term)

$$P' = R \times \frac{1-(1+i)^{-n}}{i} \times (1+i)$$

3) Payment (pay at the end of term)

$$R = P \times \frac{i}{1-(1+i)^{-n}}$$

n = term
i = rate of interest

[Example]

1) To find the present value of annuity which will be paid 233 dollars at the end of every half year term for 8 years (The rate of compound interest is 5%).
2) Same as above but, paid at the top of every half year term for 8 years.
3) To find the annual payment which should be paid back 10,000 dollars for 5 years (The rate of compound interest is 8%).

SHARP

ANGLE DESIGNATION: DEG RAD GRAD

TITLE PRESENT VALUE & PAYMENT FOR AN ANNUITY (by compound interest)

PROGRAM NO. P2-H-4

[Operation]

Example 1;

Input	Key operation	Display
1)	CA S/E	0.
2) amount for end of every half year term	233 S/E	233.
3) rate	5 S/E	5.
4) term	8 S/E	0.
5) number of settlement term	2 S/E	3042.

Example 2;

1)	GTO 1 S/E	0.
2) amount for top of every half year term	233 S/E	233.
3) rate	5 S/E	5.
4) term	8 S/E	0.
5) number of settlement term	2 S/E	3118.

Example 3;

1)	GTO 2 S/E	0.
2) amount of loan	10000 S/E	10000.
3) rate	8 S/E	8.
4) term	5 S/E	0.
5) number of settlement term	2 S/E	1233.

Note:

1) When the number of settlement term is more than once a year operate as n S/E , and otherwise just operate S/E .
2) Unit of interest is a dollar.
3) Under a dollar, Round off.

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0			C·CE			35	32			=			84
1	F	GTS	3	F	14	03	33		F	int		F	84
2		RM	1		65	01	34			S/E			85
3			x			54	35	F	LBL	2	F	13	02
4		RM	4		65	04	36			C·CE			35
5			÷			44	37	F	GTS	3	F	14	03
6		RM	2		65	02	38		RM	1		65	01
7			+			74	39			x			54
8			5			05	40		RM	2		65	02
9			EXP			41	41			÷			44
10			1			01	42		RM	4		65	04
11			+/−			82	43			+			74
12			=			84	44			5			05
13		F	int		F	84	45			EXP			41
14			S/E			85	46			1			01
15	F	LBL	1	F	13	01	47			+/−			82
16			C·CE			35	48			=			84
17	F	GTS	3	F	14	03	49		F	int		F	84
18		RM	2		65	02	50			S/E			85
19			+			74	51	F	LBL	3	F	13	03
20			1			01	52		F	CAM		F	45
21			x			54	53		F	HLT		F	12
22		RM	4		65	04	54		x→M	1		55	01
23			x			54	55		F	HLT		F	12
24		RM	1		65	01	56		x→M	2		55	02
25			÷			44	57		F	HLT		F	12
26		RM	2		65	02	58		x→M	3		55	03
27			+			74	59			C·CE			35
28			5			05	60		F	HLT		F	12
29			EXP			41	61	F	$x \neq 0$	4	F	55	04
30			1			01	62	F	LBL	5	F	13	05
31			+/−			82	63		RM	2		65	02

MEMORY				LABEL			
s		4	√	s		4	√
t		5	√	t		5	√
0		6		0		6	
1	√	7		1	√	7	
2	√	8		2	√	8	
3	√	9		3	√	9	

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64			÷			44	96						
65			1			01	97						
66			0			00	98						
67			0			00	99						
68			=			84	100						
69		x→M	2		55	02	101						
70			+			74	102						
71			1			01	103						
72			y^x			31	104						
73		RM	3		65	03	105						
74			+/−			82	106						
75			=			84	107						
76			+/−			82	108						
77			+			74	109						
78			1			01	110						
79			=			84	111						
80		x→M	4		55	04	112						
81			S/E			85	113						
82	F	LBL	4	F	13	04	114						
83		x→M	5		55	05	115						
84		RM	2		65	02	116						
85			÷			44	117						
86		RM	5		65	05	118						
87			=			84	119						
88		x→M	2		55	02	120						
89		RM	3		65	03	121						
90			x			54	122						
91		RM	5		65	05	123						
92			=			84	124						
93		x→M	3		55	03	125						
94		GTO	5		14	05	126						
95			S/E			85	127						

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE PRESENT & FUTURE VALUE OF A SINGLE PAYMENT LOAN (by compound interest)

PROGRAM NO.
P2-H-5

[Formula]

present value = future value $\times (1+i)^{-n}$

= present value $\times (1+i)^{n}$

i = rate of interest

n = term

[Example]

1) To find the future value when you deposit 1,500 dollars for 3 years. (Rate: 6%, compounded every year)
2) Same as above but compounded twice a year.
3) To find the principal of the future value 500 dollars that is deposited for 2 years. (Rate: 6.5%, compounded every year)

[Operation]

Input	Key operation	Display
Example 1;		
1)	CA	0.
2) principal	1500 S/E	1500.
3) rate	6 S/E	6.
4) term	3 S/E	0.
5)	S/E	1787. (future value)
Example 2;		
1)	CA	0.
2) principal	1500 S/E	1500.
3) rate	6 S/E	6.
4) term	3 S/E	0.
5) number of settlement term	2 S/E	1791. (future value)

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE PRESENT & FUTURE VALUE OF A SINGLE PAYMENT LOAN (by compound interest)

PROGRAM NO.
P2-H-5

Example 3;

1)	CA	0
2)	GTO 2 S/E	0
3) future value	500 S/E	500
4) rate	6.5 S/E	6.5
5) term	2 S/E	2
6) number of settlement term	S/E	441 (present value)

Note:

1) When the number of settlement term is more than once a year, operate as n S/E , and otherwise just operate S/E .
2) Unit of interest is a dollar.
3) Under a dollar, Round off (5/4).

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0	x→M	1	55	01	32	RM	5	65	05
1	F	HLT	F	12	33		=		84
2	x→M	2	55	02	34	x→M	2	55	02
3	F	HLT	F	12	35	RM	3	65	03
4	x→M	3	55	03	36		x		54
5		C·CE		35	37	RM	5	65	05
6	F	HLT	F	12	38		=		84
7	F $x\neq0$	3	F 55	03	39	x→M	3	55	03
8	F LBL	4	F 13	04	40	GTO	4	14	04
9	RM	2	65	02	41		S/E		85
10		÷		44	42	F LBL	2	F 13	02
11		1		01	43	F	HLT	F	12
12		0		00	44	x→M	1	55	01
13		0		00	45	F	HLT	F	12
14		+		74	46	x→M	2	55	02
15		1		01	47	F	HLT	F	12
16		y^x		31	48	x→M	3	55	03
17	RM	3	65	03	49		C·CE		35
18		x		54	50	F	HLT	F	12
19	RM	1	65	01	51	F $x\neq0$	5	F 55	05
20		+		74	52	F LBL	6	F 13	06
21		5		05	53	RM	2	65	02
22		EXP		41	54		÷		44
23		1		04	55		1		01
24		+/−		82	56		0		00
25		=		84	57		0		00
26	F	int	F	84	58		+		74
27		S/E		85	59		1		01
28	F LBL	3	F 13	03	60		y^x		31
29	x→M	5	55	05	61	RM	3	65	03
30	RM	2	65	02	62		=		84
31		÷		44	63	F	1/x	F	43

MEMORY

s			4		
t			5	√	
0			6		
1	√		7		
2	√		8		
3	√		9		

LABEL

s			4	√	
t			5	√	
0			6	√	
1			7		
2	√		8		
3	√		9		

STEP	KEY		KEY CODE		STEP	KEY	KEY CODE
64		x		54	96		
65	RM	1	65	01	97		
66		=		84	98		
67		+		74	99		
68		5		05	100		
69		EXP		41	101		
70		1		01	102		
71		+/−		82	103		
72		=		84	104		
73	F	int	F	84	105		
74		S/E		85	106		
75	F LBL	5	F 13	05	107		
76	x→M	5	55	05	108		
77	RM	2	65	02	109		
78		÷		44	110		
79	RM	5	65	05	111		
80		=		84	112		
81	x→M	2	55	02	113		
82	RM	3	65	03	114		
83		x		54	115		
84	RM	5	65	05	116		
85		=		84	117		
86	x→M	3	55	03	118		
87	GTO	6	14	06	119		
88		S/E		85	120		
89					121		
90					122		
91					123		
92					124		
93					125		
94					126		
95					127		

NOTE

SHARP

ANGLE DESIGNATION: DEG RAD GRAD

TITLE: MORTGAGE LOAN

PROGRAM NO.: P2-H-6

[Formula]

monthly payment

$$= (\text{price} - \text{down payment}) \times \frac{i}{1-(1+i)^{-n}}$$

i = rate of interest

n = number of payment

Note:

1) Unit of interest is a dollar.
2) Under a dollar, Round up.

[Example]

To find a monthly payment for 1,000 dollars stereo in 11 months. (Down payment is 200 dollars. Monthly rate: 1%)

[Operation]

Input	Key operation		Display
1)		CA S/E	0.
2) price	1000	S/E	1000.
3) down payment	200	S/E	200.
4) monthly rate	1	S/E	1.
5) number of payment	11	S/E	78. (monthly payment)
		S/E	72. (last payment)

Note:

Last payment is adjusted to the total of payment.

STEP	KEY		KEY CODE	STEP	KEY		KEY CODE
0	F	CAM	F 45	32		÷	44
1	F	HLT	F 12	33		1	01
2	x→M	1	55 01	34		0	00
3	F	HLT	F 12	35		0	00
4	x→M	2	55 02	36		+	74
5	F	HLT	F 12	37		9	09
6	x→M	3	55 03	38		EXP	41
7	F	HLT	F 12	39		1	01
8	x→M	4	55 04	40		+/−	82
9	RM	3	65 03	41		=	84
10		÷	44	42	F	int	F 84
11		1	01	43	x→M	5	55 05
12		0	00	44	F	HLT	F 12
13		0	00	45	RM	4	65 04
14		+	74	46		−	64
15		1	01	47		1	01
16		y^x	31	48		=	84
17	RM	4	65 04	49	x→M	8	55 08
18		+/−	82	50	RM	3	65 03
19		=	84	51		÷	44
20		+/−	82	52		1	01
21		+	74	53		0	00
22		1	01	54		0	00
23		=	84	55		+	74
24	x→M	5	55 05	56		1	01
25	RM	1	65 01	57		=	84
26		−	64	58	x→M	6	55 06
27	RM	2	65 02	59	RM	1	65 01
28		×	54	60		−	64
29	RM	3	65 03	61	RM	2	65 02
30		÷	44	62		=	84
31	RM	5	65 05	63	x→M	7	55 07

MEMORY				LABEL			
s		4	√	s		4	
t		5		t		5	
0		6	√	0		6	
1	√	7	√	1	√	7	
2	√	8	√	2		8	
3	√	9		3		9	

STEP	KEY		KEY CODE			STEP	KEY		KEY CODE		
64	F	LBL	1	F	13	01	96				
65		RM	7		65	07	97				
66			×			54	98				
67		RM	6		65	06	99				
68			+			74	100				
69			9			09	101				
70			EXP			41	102				
71			1			01	103				
72			+/−			82	104				
73			=			84	105				
74		F	int		F	84	106				
75			−			64	107				
76		RM	5		65	05	108				
77			=			84	109				
78		x→M	7		55	07	110				
79			1			01	111				
80			+/−			82	112				
81		M+	8		75	08	113				
82		RM	8		65	08	114				
83	F	x≠0	1	F	55	01	115				
84		RM	7		65	07	116				
85			S/E			85	117				
86							118				
87							119				
88							120				
89							121				
90							122				
91							123				
92							124				
93							125				
94							126				
95							127				

NOTE

SHARP

ANGLE DESIGNATION: DEG RAD GRAD

TITLE **DEPRECIATION (FIXED RATE METHOD)**

PROGRAM NO. P2–H–7

[Formula]

Depreciation of

every term = acquisitioncost x rate of depreciation

amount at the end term = acquisitioncost – depreciation

[Example]

[1]

	acquisitioncost	depreciation of every term	amount at the end of term
	65,000	2,333	62,667
	55,000	1,974	53,026
Total	120,000	4,307	

[2] Schedule of depreciation

Aquisitioncost of machine is 700,000 dollars the durable year is 7 years and the scrap value is 10% of aquisitioncost. Schedule the depreciation of a half yearly settlement for this machine

$$\text{rate of depreciation} = 1-\left(\frac{\text{scrap value}}{\text{acquisitioncost}}\right)^{\frac{1}{n}}$$

n = number of settlement term

term	value at the beginning of each term	depreciation of every term	aggregate of depreciation
1	700,000	106,162	106,162
2	593,838	90,061	196,223
3	503,777	76,402	272,626
⋮			
7	260,926	39,572	478,646
8	221,354	33,571	512,217
9	187,783	28,479	540,696
⋮			
13	97,260	14,750	617,490
14	82,510	12,510	630,000

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE DEPRECIATION (FIXED RATE METHOD)

PROGRAM NO. P2-H-7

[Operation]

Example 1;

	Input	Key operation	Display
1)		CA F CAM	0.
2)	rate	3.59 S/E	0.0359
3)	acquisitioncost	55000 S/E	1974. (depreciation)
		S/E	53026. (amount at the end of term)

Repeat the same operation as shown above.

65000 S/E	2333. (depreciation)
S/E	62667. (amount at the of end term)
RM 2	120000. (total of acquisitioncost)
RM 3	4307. (total of depreciation)

Example 2;

1)		CA F CAM	0.
2)		GTO 3 S/E	0.
3)	acquisitioncost	700000 S/E	700000.
4)	rate of scrap value	10 S/E	10.
5)	number of settlement term	14 S/E	106162 (depreciation of first term)
		S/E	593838 (value at the beginning of second term)
		S/E	90061 (depreciation of second term)
		S/E	503777 (value at the beginning of 3rd term)

Repeat the same operation as shown above until piping.

To get scrap value and aggregate of depreciation, operate as follow

RM 5	70000 (scrap value)
RM 6	630000 (aggregate of depreciation)

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0			÷			44	32		x→M	7		55	07
1			1			01	33		RM	5		65	05
2			0			00	34			x			54
3			0			00	35		RM	9		65	09
4			=			84	36			÷			44
5		x→M	0		55	00	37			1			01
6	F	LBL	1	F	13	01	38			0			00
7		F	HLT		F	12	39			0			00
8		x→M	1		55	01	40			=			84
9		M+	2		75	02	41			÷			44
10			x			54	42		RM	5		65	05
11		RM	0		65	00	43			=			84
12			=			84	44		x→M	s		55	82
13		F	int		F	84	45		RM	7		65	07
14		M+	3		75	03	46		F	1/x		F	43
15		x→M	t		55	83	47		x→M	t		55	83
16		F	HLT		F	12	48		RM	s		65	82
17		RM	t		65	83	49			y^x			31
18			+/–			82	50		RM	t		65	83
19			+			74	51			=			84
20		RM	1		65	01	52			+/–			82
21			=			84	53			+			74
22		M+	4		75	04	54			1			01
23		GTO	1		14	01	55			=			84
24			S/E			85	56		x→M	8		55	08
25	F	LBL	3	F	13	03	57			5			05
26		F	CAM		F	45	58			x			54
27		F	HLT		F	12	59			EXP			41
28		x→M	5		55	05	60			6			06
29		F	HLT		F	12	61			+/–			82
30		x→M	9		55	09	62		M+	8		75	08
31		F	HLT		F	12	63		RM	8		65	08

	MEMORY				LABEL			
s	√		4		s		4	√
t	√		5	√	t		5	
0	√		6	√	0		6	
1	√		7	√	1	√	7	
2	√		8	√	2		8	
3	√		9	√	3	√	9	

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64			x			54	96						
65			EXP			41	97						
66			5			05	98						
67			=			84	99						
68		F	int		F	84	100						
69			x			54	101						
70			EXP			41	102						
71			5			05	103						
72			+/−			82	104						
73			=			84	105						
74		x→M	8		55	08	106						
75	F	LBL	4	F	13	04	107						
76		RM	5		65	05	108						
77			x			54	109						
78		RM	8		65	08	110						
79			=			84	111						
80		F	int		F	84	112						
81		M+	6		75	06	113						
82		F	HLT		F	12	114						
83			+/−			82	115						
84		M+	5		75	05	116						
85		RM	5		65	05	117						
86		F	HLT		F	12	118						
87			1			01	119						
88			+/−			82	120						
89		M+	7		75	07	121						
90		RM	7		65	07	122						
91	F	x≠0	4	F	55	04	123						
92		GTO	t		14	83	124						
93	F	LBL	t	F	13	83	125						
94		RM	5		65	05	126						
95			S/E			85	127						

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **TAKING MARBLES**

PROGRAM NO.
P2–X–1

[Formula]

You can play the game of taking marbles with the calculator, beginning with a collection of N marbles. Each player (you or the calculator) alternately subtracts the number (one, two or three) from the total number until the last one is left. The player who takes the last one loses the game. After each play, the machine displays the remaining total. When a negative sign is displayed, it means that the next is your turn, when a positive display shows the machine's turn. You make the first move.

[Example]

Begin the game by setting the number of N as 15.
n: the number of marbles which you are taking this move.

[Operation]

		CA	
(N)	15	S/E	−15
(n)	3	S/E	12
Calculator		S/E	− 9
n	2	S/E	7
Calculator		S/E	− 5
n	3	S/E	2
Calculator		S/E	− 1
You take the last one.			
	1	S/E	Emitting the peep sound.

Note: If you win, the display will be filled with 7.

STEP	KEY						KEY CODE		STEP	KEY						KEY CODE		
0			7				07		32			F	HLT			F	12	
1			7				07		33				‡				45	
2			7				07		34			RM	2			65	02	
3			7				07		35	F	$x<0$	2		F	65	02		
4			7				07		36			GTO	3			14	03	
5			7				07		37	F	LBL	2		F	13	02		
6			7				07		38				‡				45	
7			7				07		39			GTO	4			14	04	
8			7				07		40	F	LBL	3		F	13	03		
9			7				07		41				1				01	
10		x→M	4			55	04		42				+/–				82	
11			C·CE				35	43				x→M	2			55	02	
12		F	HLT			F	12		44				0				00	
13		x→M	0			55	00		45			x→M	1			55	01	
14			+/–				82		46	F	LBL	5		F	13	05		
15		F	HLT			F	12		47			RM	1			65	01	
16	F	LBL	4	F	13		04		48			x→M	t			55	83	
17			‡				45		49				3				03	
18			1				01		50	F	$x=t$	6		F	75	06		
19		x→M	2			55	02		51				1				01	
20			‡				45		52			M+	1			75	01	
21	F	LBL	7	F	13		07		53				+/–				82	
22			+/–				82		54				+				74	
23		M+	0			75	00		55			RM	0			65	00	
24		RM	0			65	00		56				–				64	
25	F	$x\neq0$	0	F	55		00		57			RM	1			65	01	
26		GTO	1			14	01		58				÷				44	
27	F	LBL	0	F	13		00		59				4				04	
28			x				54		60				=				84	
29		RM	2			65	02		61			F	frac			F	83	
30			=				84		62	F	$x\neq0$	5		F	55	05		
31		x→M	2			55	02		63			RM	1			65	01	

MEMORY				LABEL			
s		4	√	s		4	√
t	working	5		t	√	5	√
0	Total	6		0	√	6	√
1	0	7		1	√	7	√
2	+ or –	8		2	√	8	√
3		9		3	√	9	

STEP	KEY						KEY CODE		STEP	KEY						KEY CODE		
64		GTO	7			14	07		96									
65	F	LBL	6	F	13	06			97									
66			1			01			98									
67		GTO	7			14	07		99									
68	F	LBL	1	F	13	01			100									
69		RM	2			65	02		101									
70	F	$x<0$	8	F	65	08			102									
71	F	GTS	s	F	14	82			103									
72	F	GTS	s	F	14	82			104									
73	F	GTS	s	F	14	82			105									
74		F	HLT		F	12			106									
75	F	LBL	8	F	13	08			107									
76		RM	4		65	04			108									
77		F	HLT		F	12			109									
78			S/E			85			110									
79	F	LBL	s	F	13	82			111									
80		GTO	t		14	83			112									
81	F	LBL	t	F	13	83			113									
82			S/E			85			114									
83									115									
84									116									
85									117									
86									118									
87									119									
88									120									
89									121									
90									122									
91									123									
92									124									
93									125									
94									126									
95									127									

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2–X–2

TITLE **GUESS THE NUMBER GAME**

[Formula]

You guess the integral number (0 – 9) which the calculator has in memory. You play the game by setting the expected number B and the bet number C ($\leq$A), starting from the point A. If the number B coincides with the number of the calculator, the bet number C increases by D times (>1) which is your point. If your guess in not correct, your point becomes A – C. If the difference of the number is 1, you get the point of E times (≤ 1) of C. You lose the game if A is exhausted.

[Example]

A = 100

[Operation]

		CA
First value of random number	0.4	S/E
E times	0.5	S/E
D times	4	S/E
Point A	100	S/E
→		
Bet number C		S/E
Expected number B		S/E
		S/E

The number of the calculator point

STEP	KEY			KEY CODE	
0		x→M	5	55	05
1		F	HLT	F	12
2		x→M	4	55	04
3		F	HLT	F	12
4		x→M	3	55	03
5		F	HLT	F	12
6		x→M	0	55	00
7	F	LBL	s	F 13	82
8		F	HLT	F	12
9		x→M	2	55	02
10		F	HLT	F	12
11		x→M	1	55	01
12		RM	2	65	02
13			+/–		82
14		M+	0	75	00
15		RM	0	65	00
16	F	$x<0$	0	F 65	00
17		GTO	1	14	01
18	F	LBL	0	F 13	00
19			0		00
20		x→M	0	55	00
21		RM	0	65	00
22			+		74
23		RM	2	65	02
24			=		84
25		x→M	2	55	02
26	F	LBL	1	F 13	01
27		F	π	F	41
28			+		74
29		RM	5	65	05
30			=		84
31			y^x		31

STEP	KEY			KEY CODE	
32			5		05
33			=		84
34		F	frac	F	83
35		x→M	5	55	05
36			x		54
37			1		01
38			0		00
39			=		84
40		F	int	F	84
41		F	HLT	F	12
42			–		64
43		RM	1	65	01
44			=		84
45	F	$x\neq 0$	2	F 55	02
46		GTO	3	14	03
47	F	LBL	2	F 13	02
48		F	abs	F	82
49		x→M	t	55	83
50			1		01
51	F	$x=t$	4	F 75	04
52			9		09
53	F	$x=t$	4	F 75	04
54		GTO	5	14	05
55	F	LBL	4	F 13	04
56		RM	4	65	04
57		GTO	6	14	06
58	F	LBL	3	F 13	03
59		GTO	t	14	83
60	F	LBL	t	F 13	83
61		RM	3	65	03
62	F	LBL	6	F 13	06
63			x		54

MEMORY					
s			4		
t	√		5		
0			6		
1			7		
2			8		
3			9		

LABEL			
s	√	4	√
t	√	5	√
0	√	6	√
1	√	7	
2	√	8	
3	√	9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64		RM	2	65	02	96								
65		M+	0	75	00	97								
66	F	LBL	5	F 13	05	98								
67		RM	0	65	00	99								
68		GTO	s	14	82	100								
69			S/E		85	101								
70						102								
71						103								
72						104								
73						105								
74						106								
75						107								
76						108								
77						109								
78						110								
79						111								
80						112								
81						113								
82						114								
83						115								
84						116								
85						117								
86						118								
87						119								
88						120								
89						121								
90						122								
91						123								
92						124								
93						125								
94						126								
95						127								

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2–X–3

TITLE **SINKING A SUBMARINE**

[Formula]

This is a game to sink a submarine which is navigating under water as shown in the figure by throwing down the mine. The calculator emits the peep sound 10 times if you destroy the submarine. And if you give a shock to the submarine, you can hear the peep emitting 2 times. Error symbol turns on in case you cannot hit it.

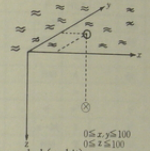
[Example]

10 digits number A
2 digits number B
} First value

m = 25 . . . . . distance to give a shock

n = 15 . . . . . distance to sink the submarine

[Operation]



		CA	
(A)	1234567890	S/E	1
(B)	50	S/E	0
(m)	25	S/E	
(n)	15	S/E	
(x)	50	S/E	
(y)	50	S/E	
(z)	50	S/E	Error symbol (no hit)
		CE	
		S/E	
		↓	
(x)	40	S/E	
(y)	50	S/E	
(z)	50	S/E	Peeping 2 times
		S/E	(Giving a shock to the submarine)
		↓	

SHARP

角度指定
DEG RAD GRAD

TITLE **SINKING A SUBMARINE**

PROGRAM NO. P2-X-3

(x)	30	S/E	Peeping 10 times
(y)	50	S/E	(Destroyed and sank the submarine!)
(z)	50	S/E	x_{sub} 23.84198476
		S/E	y_{sub} 47.20684827
		S/E	z_{sub} 54.89819871

The position of the submarine.

(sub–submarine)

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		F CAM	F	45	32		F log	F	33
1		M+ 7	75	07	33		x→M 5	55	05
2		M+ 4	75	04	34		RM 7	65	07
3		F x^3	F	44	35		In		33
4		M+ 5	75	05	36		x→M 7	55	07
5		M+ 6	75	06	37		C·CE		35
6		1		01	38		F HLT	F	12
7		M+ 3	75	03	39		x→M 0	55	00
8		F HLT	F	12	40		F HLT	F	12
9		x→M 0	55	00	41		x→M 6	55	06
10	F	LBL 0	F 13	00	42	F	LBL 3	F 13	03
11		RM 7	65	07	43		F HLT	F	12
12		x→M s	55	82	44		x→M 1	55	01
13		M+ 7	75	07	45		F HLT	F	12
14		F x^3	F	44	46		x→M 2	55	02
15		M+ 6	75	06	47		F HLT	F	12
16		RM 4	65	04	48		x→M 3	55	03
17		M+ 4	75	04	49		RM 1	65	01
18		x		54	50		–		64
19		RM s	65	82	51		RM 4	65	04
20		M+ 5	75	05	52		=		84
21		1		01	53		F x^3	F	44
22		M+ 3	75	03	54		x→M t	55	83
23		RM 3	65	03	55		RM 2	65	02
24		–		64	56		–		64
25		RM 0	65	00	57		RM 5	65	05
26		=		84	58		=		84
27	F	$x \neq 0$ 0	F 55	00	59		F x^2	F	44
28		RM 4	65	04	60		M+ t	75	83
29		F log	F	33	61		RM 3	65	03
30		x→M 4	55	04	62		–		64
31		RM 5	65	05	63		RM 7	65	07

MEMORY

s	√	4	x'		
t		5	y'		
0		6	n		
1	x	7	z'		
2	y	8			
3	z	9			

LABEL

s	√	4			
t	√	5			
0	√	6			
1	√	7			
2	√	8			
3	√	9			

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64			=			84	96	F	LBL	7	F	13	07
65		F	x^2		F	44	97	F	GTS	s	F	14	82
66		M+	t		75	83	98			1			01
67		RM	t		65	83	99			+/−			82
68		F	√		F	42	100		M+	s		75	82
69		x→M	s		55	82	101		RM	s		65	82
70			−			64	102	F	x≠0	7	F	55	07
71		RM	0		65	00	103		RM	4		65	04
72			‡			45	104		F	HLT		F	12
73			=			84	105		RM	5		65	05
74	F	x<0	1	F	65	01	106		F	HLT		F	12
75		GTO	2		14	02	107		RM	7		65	07
76	F	LBL	1	F	13	01	108		F	HLT		F	12
77			2			02	109			S/E			85
78		F	$\sin^{-1}$		F	22	110	F	LBL	s	F	13	82
79		GTO	3		14	03	111		GTO	t		14	83
80	F	LBL	2	F	13	02	112	F	LBL	t	F	13	83
81		RM	6		65	06	113			S/E			85
82			−			64	114						
83		RM	s		65	82	115						
84			=			84	116						
85	F	x<0	4	F	65	04	117						
86		GTO	6		14	06	118						
87	F	LBL	4	F	13	04	119						
88	F	GTS	s	F	14	82	120						
89	F	GTS	s	F	14	82	121						
90			C·CE			35	122						
91		GTO	3		14	03	123						
92	F	LBL	6	F	13	06	124						
93			1			01	125						
94			0			00	126						
95		x→M	s		55	82	127						

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **LUNAR LANDER**

PROGRAM NO.
P2–X–4

[Formula]

This is a game of landing a rocket on the moon with a strictly limited fuel supply. The rocket is free-falling. So, you must ignite your rocket to slow your descent. But if you burn too early or too fast, you will run out of fuel and go up. then you will have nothing to look forward to but Moon dust. If you burn too slow, your rocket will crash into the surface of the moon. The object is to space your burns just night so that you will align on the surface of the moon with a minimum downward velocity.

Gravity of the moon is to be regarded as 5m/s²
During the unit time, a burn of 5 units of fuel will just cancel the gravity.

First give the data to the calculator; starting point (altitude) Ho, first velocity Vo, first fuel Fo. Then, set the fuel to be burnt at every altitude.

[Example]

$H = H_o + V_o t + \frac{1}{2} a t^2$

$V = V_o + a t$

$V^2 = V_o^2 + 2 aH$

$H_o = 500$ (m)

$V_o = -50$ (m/s) (downward)

$F_o = 120$

H : altitude
V : velocity
a : gravity acceleration
t : time
V : first velocity
Ho: first altitude
Vo: first velocity
Fo: first fuel
F : burnt fuel
F' : remaining fuel

The object is to make V and H to zero, by setting the fuel to be burnt at every altitude. If you crash, the calculator emits the peep sound.

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2-X-4

TITLE **LUNAR LANDER**

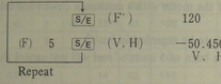
[Operation]

CA

(H_0) 500 S/E

(V_0) −50 S/E

(F_0) 120 S/E (V_0, H_0)



Note:

1. If you crash, the calculator emits peep 20 times.
   The display shows the crashing velocity.
2. V and H are shown simultaneously on the display;
   3 digits . 3 digits 1111
   V H

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
0		F	CAM	F 45	32		=		84
1		x→M	0	55 00	33		GTO	1	14 01
2		F	HLT	F 12	34	F	LBL	0	F 13 00
3		x→M	1	55 01	35		−		64
4		F	HLT	F 12	36		RM	4	65 04
5		x→M	2	55 02	37		−		64
6	F	LBL	4	F 13 04	38		RM	5	65 05
7		RM	0	65 00	39		=		84
8		F	int	F 84	40	F	LBL	1	F 13 01
9			x	54	41		F	HLT	F 12
10			EXP	41	42		RM	2	65 02
11			3	03	43		F	HLT	F 12
12			+/−	82	44		x→M	t	55 83
13			=	84	45		RM	2	65 02
14		x→M	4	55 04	46	F	x<t	2	F 85 02
15			1	01	47		−		64
16			1	01	48		RM	t	65 83
17			1	01	49		=		84
18			1	01	50		x→M	2	55 02
19			x	54	51		RM	t	65 83
20			EXP	41	52		−		64
21			7	07	53		5		05
22			+/−	82	54		=		84
23			=	84	55		x→M	6	55 06
24		x→M	5	55 05	56		÷		44
25		RM	1	65 01	57		2		02
26		F	int	F 84	58		+		74
27	F	x<0	0	F 65 00	59		RM	0	65 00
28			+	74	60		+		74
29		RM	4	65 04	61		RM	1	65 01
30			+	74	62		=		84
31		RM	5	65 05	63		x→M	0	55 00

MEMORY				LABEL			
s	working	4		s		4	√
t	F	5		t	√	5	
0	H	6		0	√	6	
1	V	7		1	√	7	
2	F'	8		2	√	8	
3	A	9		3	√	9	

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64	F	$x<0$	3	F	65	03	96						
65		RM	6		65	06	97						
66		M+	1		75	01	98						
67		GTO	4		14	04	99						
68	F	LBL	2	F	13	02	100						
69		RM	1		65	01	101						
70		F	x^2		F	44	102						
71		x→M	7		55	07	103						
72		RM	0		65	00	104						
73			x			54	105						
74			1			01	106						
75			0			00	107						
76			+			74	108						
77		RM	7		65	07	109						
78			=			84	110						
79		F	$\sqrt{}$		F	42	111						
80			+/−			82	112						
81		x→M	1		55	01	113						
82	F	LBL	3	F	13	03	114						
83			2			02	115						
84			0			00	116						
85		x→M	t		55	83	117						
86			0			00	118						
87		x→M	s		55	82	119						
88	F	LBL	t	F	13	83	120						
89			1			01	121						
90		M+	s		75	82	122						
91		RM	s		65	82	123						
92	F	$x<t$	t	F	85	83	124						
93		RM	1		65	01	125						
94			S/E			85	126						
95							127						

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE **CALENDAR CALCULATION**

PROGRAM NO.
P2–X–5

[Formula]

To solve for an unknown day of the week in a known month and year.

[Example]

February 4th, 1977

(1, 2, 3, 4, 5, 6, 0 correspond to Mon., Tue., Wed., Thu., Fri., Sat., Sun., respectively.)

[Operation]

		CA	
	0	S/E	
Year	1977	S/E	
Month	2	S/E	
Date	4	S/E	N
	+		0 (n) = x→M 7
		S/E	5

Note:

1. n = 0 . . . ~2000
   n = 1 . . . ~1900, February 28
   n = 2 . . . ~1800, February 28
2. Date can be obtained by second step with the key operation of +, n, =, +/−, M+ 7, RM, 7.

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
0		x→M	0		55	00	32	F	LBL	3	F	13	03
1		F	HLT		F	12	33			1			01
2		x→M	1		55	01	34			8			08
3		F	HLT		F	12	35			6			06
4		x→M	2		55	02	36			7			07
5		F	HLT		F	12	37		M+	1		75	01
6		x→M	3		55	03	38	F	LBL	1	F	13	01
7		RM	0		65	00	39		RM	2		65	02
8	F	x≠0	0	F	55	00	40			−			64
9		GTO	1		14	01	41			3			03
10	F	LBL	0	F	13	00	42			=			84
11			−			64	43	F	x<0	4	F	65	04
12			1			01	44			1			01
13			=			84	45		M+	2		75	02
14	F	x≠0	2	F	55	02	46		GTO	5		14	05
15			1			01	47	F	LBL	4	F	13	04
16			9			09	48			1			01
17			2			02	49			3			03
18			5			05	50		M+	2		75	02
19		M+	1		75	01	51			1			01
20		GTO	1		14	01	52			+/−			82
21	F	LBL	2	F	13	02	53		M+	1		75	01
22			−			64	54	F	LBL	5	F	13	05
23			1			01	55			3			03
24			=			84	56			6			06
25	F	x≠0	3	F	55	03	57			5			05
26			1			01	58			·			83
27			9			09	59			2			02
28			1			01	60			5			05
29			1			01	61			x			54
30		M+	1		75	01	62		RM	1		65	01
31		GTO	1		14	01	63			=			84

MEMORY

s	√	4
t	√	5
0	S, T, M	6
1	y	7
2	m	8
3	d	9

LABEL

s		4
t		5
0	√	6
1	√	7
2	√	8
3	√	9

STEP	KEY			KEY CODE			STEP	KEY			KEY CODE		
64		F	int		F	84	96			‡			45
65		x→M	s		55	82	97			=			84
66		RM	2		65	02	98		GTO	t		14	83
67			x			54	99	F	LBL	t	F	13	83
68			3			03	100		F	HLT		F	12
69			0			00	101			S/E			85
70			·			83	102						
71			6			06	103						
72			=			84	104						
73		F	int		F	84	105						
74			+			74	106						
75		RM	s		65	82	107						
76			+			74	108						
77		RM	3		65	03	109						
78			−			64	110						
79			6			06	111						
80			2			02	112						
81			1			01	113						
82			0			00	114						
83			4			04	115						
84			9			09	116						
85			=			84	117						
86		F	HLT		F	12	118						
87		x→M	t		55	83	119						
88			÷			44	120						
89			7			07	121						
90			=			84	122						
91		F	int		F	84	123						
92			x			54	124						
93			7			07	125						
94			−			64	126						
95		RM	t		65	83	127						

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD
PROGRAM NO.
P2–X–6

TITLE **BIORHYTHM**

[Formula]

Biorhythm is a calculation to see your condition of physique (P), sensibility (S) and Intelligence (I), which is decided by your date of birth. P, S and I have the following cycles;

P : 23 days of cycle
S : 28 days of cycle
I : 33 days of cycle

From this, date on which your condition is bad is calculated as below:

P : 0, 11 or 12
S : 0, 14
I : 0, 16 or 17

Calculation, however, can only be made for the person who was born on or after March 1, 1900.

[Example]

To see the condition of P, S and I on March 3, 1977 for the man who was born on February 4, 1954.

[Operation]

Birth date
- Year : 1954 [S/E]
- Month : 2 [S/E]
- Date : 4 [S/E]

Biorhythm
- Year : 1977 [S/E]
- Month : 3 [S/E]
- Date : 3 [S/E]

(P) 10 . . . . (Bad condition: March 4 or 5)

[S/E] (S) 0 . . . . (Bad condition)

[S/E] (I) 13 . . . . (Bad condition: after 3 days)

[S/E]

Repeat (peep)

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
0		x→M	1	55	01	32	F	GTS	0	F 14	00
1		F	HLT	F	12	33		F	HLT	F	12
2		x→M	2	55	02	34		GTO	t	14	83
3		F	HLT	F	12	35			S/E		85
4		x→M	3	55	03	36	F	LBL	0	F 13	00
5	F	GTS	s	F 14	82	37		RM	t	65	83
6		x→M	0	55	00	38			÷		44
7	F	LBL	t	F 13	83	39		RM	s	65	82
8		F	HLT	F	12	40			=		84
9		x→M	1	55	01	41		F	int	F	84
10		F	HLT	F	12	42			x		54
11		x→M	2	55	02	43		RM	s	65	82
12		F	HLT	F	12	44			–		64
13		x→M	3	55	03	45		RM	t	65	83
14	F	GTS	s	F 14	82	46			‡		45
15			–		64	47			=		84
16		RM	0	65	00	48			S/E		85
17			=		84	49	F	LBL	s	F 13	82
18		x→M	t	55	83	50		RM	2	65	02
19			2		02	51			–		64
20			3		03	52			3		03
21		x→M	s	55	82	53			=		84
22	F	GTS	0	F 14	00	54	F	x<0	3	F 65	03
23		F	HLT	F	12	55		RM	1	66	01
24			2		02	56		x→M	5	55	05
25			8		08	57		RM	2	65	02
26		x→M	s	55	82	58			+		74
27	F	GTS	0	F 14	00	59			1		01
28		F	HLT	F	12	60			=		84
29			3		03	61		x→M	6	55	06
30			3		03	62		GTO	4	14	04
31		x→M	s	55	82	63	F	LBL	3	F 13	03

MEMORY				LABEL			
s	T	4		s	√	4	√
t	N'	5	√	t	√	5	
0	N	6	√	0	√	6	
1	Y	7	√	1	√	7	
2	M	8	√	2	√	8	
3	D	9		3	√	9	

STEP	KEY		KEY CODE		STEP	KEY		KEY CODE	
64	RM	1	65	01	96	RM	8	65	08
65		−		64	97		+		74
66		1		01	98	RM	3	65	03
67		=		84	99		−		64
68	x→M	5	55	05	100		6		06
69	RM	2	65	02	101		2		02
70		+		74	102		1		01
71		1		01	103		0		00
72		3		03	104		4		04
73		=		84	105		9		09
74	x→M	6	55	06	106		=		84
75	F LBL	4	F 13	04	107		S/E		85
76		3		03	108				
77		6		06	109				
78		5		05	110				
79		·		83	111				
80		2		02	112				
81		5		05	113				
82		x		54	114				
83	RM	5	65	05	115				
84		=		84	116				
85	F	int	F	84	117				
86	x→M	8	55	08	118				
87		3		03	119				
88		0		00	120				
89		·		83	121				
90		6		06	122				
91		x		54	123				
92	RM	6	65	06	124				
93		=		84	125				
94	F	int	F	84	126				
95	M+	8	75	08	127				

NOTE

SHARP

ANGLE DESIGNATION
DEG RAD GRAD

TITLE RECORDING CHARACTERISTIC OF RIAA

PROGRAM NO.
P2–X–7

[Formula]

$$N_{dB}=10\log\left(1+4\pi^2f^2t_1^2\right)-10\log\left(1+\frac{1}{4\pi^2f^2t_2^2}\right)+10\log\left(1+\frac{1}{4\pi^2f^2t_3^2}\right)+K$$

$t_1 = 75 \times 10^{-6}$

$t_2 = 318 \times 10^{-6}$

$t_3 = 3180 \times 10^{-6}$

K : When f is 1 KHz, N = 0 (dB)

[Example]

f = 100 ····· N = −13.0884 (dB)

1000 ····· N = 0 (dB)

10000 ····· N = 13.7343 (dB)

[Operation]

CA

S/E

(t_1) 75 S/E

(t_2) 318 S/E

(t_3) 3180 S/E

1000 Hz standard value S/E (K)

Manual operation +/−, x→M, 5

(f) 100 S/E (N) −13.0884596 (dB)

Repeat

STEP	KEY			KEY CODE		STEP	KEY			KEY CODE	
0		F	CAM	F	45	32		RM	0	65	00
1		F	HLT	F	12	33			x		54
2	F	GTS	s	F 14	82	34		RM	3	65	03
3		x→M	1	55	01	35			=		84
4		F	HLT	F	12	36		F	1/x	F	43
5	F	GTS	s	F 14	82	37			+		74
6		x→M	2	55	02	38			1		01
7		F	HLT	F	12	39			=		84
8	F	GTS	s	F 14	82	40		F	log	F	33
9		x→M	3	55	03	41		M+	4	75	04
10	F	LBL	t	F 13	83	42		RM	4	65	04
11		F	HLT	F	12	43			x		54
12		F	x^2	F	44	44			1		01
13		x→M	0	55	00	45			0		00
14			x		54	46			+		74
15		RM	1	65	01	47		RM	5	65	05
16			+		74	48			=		84
17			1		01	49		F	HLT	F	12
18			=		84	50		GTO	t	14	83
19		F	log	F	33	51			S/E		85
20		x→M	4	55	04	52	F	LBL	s	F 13	82
21		RM	0	65	00	53			x		54
22			x		54	54			EXP		41
23		RM	2	65	02	55			6		06
24			=		84	56			+/−		82
25		F	1/x	F	43	57			x		54
26			+		74	58		F	π	F	41
27			1		01	59			x		54
28			=		84	60			2		02
29		F	log	F	33	61			=		84
30			+/−		82	62		F	x^3	F	44
31		M+	4	75	04	63			S/E		85

MEMORY

s		4	working
t		5	k
0	t^2	6	
1	$4\pi^2\ t_1{}^2$	7	
2	$4\pi^2\ t_2{}^2$	8	
3	$4\pi^2\ t_3{}^2$	9	

LABEL

s	√	4	
t	√	5	
0		6	
1		7	
2		8	
3		9	

SHARP PROGRAM LIBRARY

角度指定
DEG RAD GRAD

PROGRAM NO.

TITLE

P2–

STEP	KEY	KEY CODE	STEP	KEY	KEY CODE
0			32		
1			33		
2			34		
3			35		
4			36		
5			37		
6			38		
7			39		
8			40		
9			41		
10			42		
11			43		
12			44		
13			45		
14			46		
15			47		
16			48		
17			49		
18			50		
19			51		
20			52		
21			53		
22			54		
23			55		
24			56		
25			57		
26			58		
27			59		
28			60		
29			61		
30			62		
31			63		

MEMORY		LABEL	
s	4	s	4
t	5	t	5
0	6	0	6
1	7	1	7
2	8	2	8
3	9	3	9

STEP	KEY	KEY CODE	STEP	KEY	KEY CODE
64			96		
65			97		
66			98		
67			99		
68			100		
69			101		
70			102		
71			103		
72			104		
73			105		
74			106		
75			107		
76			108		
77			109		
78			110		
79			111		
80			112		
81			113		
82			114		
83			115		
84			116		
85			117		
86			118		
87			119		
88			120		
89			121		
90			122		
91			123		
92			124		
93			125		
94			126		
95			127		

NOTE

SHARP PROGRAM LIBRARY

角度指定
DEG RAD GRAD

TITLE

PROGRAM NO.
P2-

STEP	KEY	KEY CODE	STEP	KEY	KEY CODE
0			32		
1			33		
2			34		
3			35		
4			36		
5			37		
6			38		
7			39		
8			40		
9			41		
10			42		
11			43		
12			44		
13			45		
14			46		
15			47		
16			48		
17			49		
18			50		
19			51		
20			52		
21			53		
22			54		
23			55		
24			56		
25			57		
26			58		
27			59		
28			60		
29			61		
30			62		
31			63		

MEMORY			
s		4	
t		5	
0		6	
1		7	
2		8	
3		9	

LABEL			
s		4	
t		5	
0		6	
1		7	
2		8	
3		9	

STEP	KEY	KEY CODE	STEP	KEY	KEY CODE
64			96		
65			97		
66			98		
67			99		
68			100		
69			101		
70			102		
71			103		
72			104		
73			105		
74			106		
75			107		
76			108		
77			109		
78			110		
79			111		
80			112		
81			113		
82			114		
83			115		
84			116		
85			117		
86			118		
87			119		
88			120		
89			121		
90			122		
91			123		
92			124		
93			125		
94			126		
95			127		

NOTE

SHARP PROGRAM LIBRARY

角度指定
DEG RAD GRAD

TITLE

PROGRAM NO.
P2-

STEP	KEY	KEY CODE	STEP	KEY	KEY CODE
0			32		
1			33		
2			34		
3			35		
4			36		
5			37		
6			38		
7			39		
8			40		
9			41		
10			42		
11			43		
12			44		
13			45		
14			46		
15			47		
16			48		
17			49		
18			50		
19			51		
20			52		
21			53		
22			54		
23			55		
24			56		
25			57		
26			58		
27			59		
28			60		
29			61		
30			62		
31			63		

MEMORY			
s		4	
t		5	
0		6	
1		7	
2		8	
3		9	

LABEL			
s		4	
t		5	
0		6	
1		7	
2		8	
3		9	

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